APPLIED MECHANICS Reviews

A CRITICAL REVIEW OF THE WORLD LITERATURE IN APPLIED MECHANICS AND RELATED ENGINEERING SCIENCE

REVS. 1-592 VOL. 12, NO. 1 JANUARY 1959

GENERAL

Analytical Methods in Applied Mechanics 4
Computing Methods and Computers 5
Analogies 6
Kinematics, Rigid Dynamics and Oscillations 6
Instrumentation and Automatic Control 7

MECHANICS OF SOLIDS

Elasticity 9
Viscoelasticity 11
Plasticity 11
Rods, Beams and Strings 12
Plates, Shells and Membranes 13
Buckling 15
Vibrations of Solids 16
Wave Motion and Impact in Solids 19
Solid Mechanics: Fundamental 19
Soil Mechanics: Applied 20
Processing of Metals and Other Materials 21
Fracture (Including Fatigue) 22
Experimental Stress Analysis 24
Material Test Techniques 25
Properties of Engineering Materials 26
Structures: Simple 27
Structures: Composite 29
Machine Elements and Machine Design 30
Fastening and Joining Methods 32

MECHANICS OF FLUIDS

Rheology 32
Hydraulics 34
Incompressible Flow 36
Compressible Flow (Continuum and Noncontinuum Flow) 38
Boundary Layer 41
Turbulence 41
Aerodynamics 42
Vibration and Wave Motion in Fluids 43
Fluid Machinery 44
Flow and Flight Test Techniques and Measurements 45

HEAT

Thermodynamics 47
Heat and Mass Transfer 49
Combustion 53
Prime Movers and Propulsion Devices 57

COMBINED FIELDS AND MISCELLANEOUS

Magnetohydrodynamics 58
Aeroelasticity 60
Aeronautics 61
Astronautics 62
Ballistics, Explosions 63
Acoustics 63
Micromeritics 64
Porous Media 67
Geophysics, Hydrology, Oceanography, Meteorology 70
Naval Architecture and Marine Engineering 72
Friction, Lubrication and Wear 73

Books Received, 73

AMR Introduces New Topic Classification System for Its Fields of Coverage, p. 1

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APPLIED MECHANICS REVIEWS

VOL. 12, NO. 1 **MARTIN GOLAND** *Editor* JANUARY 1959

AMR Introduces New Topic Classification System for its Fields of Coverage

In the operation of a critical review journal on the scale of APPLIED MECHANICS REVIEWS, one of the most important editorial tools is a system for classification of papers, reports and books according to topical coverage. The same classification system is used to define the detailed scientific interests of our reviewers, and in this way an intelligent assignment of material can be made to our 1,500 reviewers located throughout the world.

Over the past eleven years, the fields of coverage of the REVIEWS have enlarged and expanded into new areas in keeping with the dynamic growth of engineering science. Recently, therefore, a comprehensive study was undertaken, resulting in a new topic classification system which will serve as a basis for reviewer assignment and subject headings. Starting with this issue, the REVIEWS will operate with the new system.

It is felt that our readers will be interested in the current topical coverage of the REVIEWS, and hence the new classification system is given in its complete form on the following two pages.

The Editors

GENERAL

1 ANALYTICAL METHODS IN APPLIED MECHANICS

- Algebraic equations
- Matrix, vector and tensor analysis
- Ordinary differential equations
- Partial differential equations
- Integral and integro differential equations
- Difference and difference-differential eq.
- Operational methods and transform calculus
- Complex variable theory
- Variational principles
- Dimensional analysis and similitude
- Statistics and probability
- Operations research
- Special mathematical functions and tables

2 COMPUTING METHODS AND COMPUTERS

- Numerical analysis
- Digital computers
- Digital analog computers
- Analog computers
- Coding and programming of computers

3 ANALOGIES

- Analogies primarily in solid mechanics
- Analogies primarily in fluid mechanics
- Analogies primarily in heat
- Analogies involving mixed fields

4 KINEMATICS, RIGID DYNAMICS AND OSCILLATIONS

- Statics, general
- Kinematics, particle motion
- Exterior ballistics, trajectories
- Kinematics of gears
- Rigid body dynamics, gyratheory
- General theory of dynamical systems
- Theory of small oscillations
- Theory of finite and nonlinear oscillations

5 INSTRUMENTATION AND AUTOMATIC CONTROL

- Instrumentation, general
- Instrumentation, dynamic aspects
- Open loop systems
- Linear control systems
- Nonlinear control systems
- Statistical theory of control systems
- Sampling control
- Analog simulation
- Servomechanisms
- Controlled processes or systems, automation
- Guidance systems
- Control components and instruments
- Gyroscopes and gyroscopic effects
- Data processing

6 TABLES, CHARTS, DICTIONARIES, ETC.

- Tables
- Charts and nomograms
- Dictionaries
- General bibliographies
- Standards and specifications
- Manuals

MECHANICS OF SOLIDS

7 ELASTICITY

- Linear theory
- Nonlinear theory and finite deformations
- Stress functions
- Three dimensional problems
- Two dimensional problems
- Stress concentration
- Discontinuity stresses, notch effect
- Thermoelasticity and thermal stresses
- Variational methods and theorems
- Anisotropic and nonhomogeneous media
- Saint Venant torsion and flexure
- Three dimensional torsional problems
- Contact problems and granular media

8 VISCOELASTICITY

- Continuum theory
- Molecular theory and mechanism
- Creep and stress relaxation
- Dynamical properties
- Finite deformations
- Normal stresses
- Variation of properties with temperature
- Experimental techniques and measurements

9 PLASTICITY

- Mathematical theory of plasticity
- Plastic deformations, phys. theory, dislocations
- Residual stresses
- Experimental techniques and measurements

10 RODS, BEAMS AND STRINGS

- Strings
- Beams, bending
- Beams and rods on elastic foundation
- Box beams
- Curved bars, rings
- Finite deformations, beams
- Nonhomogeneous beams
- Anisotropic beams
- Torsional problems
- Combined loading

11 PLATES, SHELLS AND MEMBRANES

- Membrane theory
- Plates, flexure and torsion
- Plates on elastic foundations
- Shells, flexure and torsion
- Stiffened and sandwich plates and shells
- Finite deformations of pl., sh., & membr.
- Anisotropic plates, shells and membranes
- Thick plates and shells

12 BUCKLING

- Gen. theory of elast. & plast. stability
- Column theory
- Buckling of rings and arches
- Buckling of framed structures
- Buckling of plates
- Buckling of shells
- Buckling of pipes and pressure vessels
- Buckling under dynamic loads
- Viscous buckling (creep buckling)
- Thermal buckling

13 VIBRATIONS OF SOLIDS

- Vibrations of strings and membranes
- Vibr. of beams (axial, lateral, torsional)
- Bend. & torsional vibr. of shafts, crit. speeds
- Vibration of plates and discs
- Vibration of shells and blades
- Vibration of structures, traffic vibr.
- Vibration of vehicles
- Vibration of machines and machine tools
- Vibration dampers, isolation and absorbers
- Vibration under random excitations
- Stability of vibration
- Experimental techniques and measurements

14 WAVE MOTION AND IMPACT IN SOLIDS

- Gen. theory of wave prop. & dispersion
- Elastic waves
- Plastic and elastoplastic waves
- Viscoelastic waves
- Interface phenomena
- Impact (general)
- Dynamic loads on structures
- Landing impact (effect of runway roughness, etc.)
- Shock damage

15 SOIL MECHANICS - FUNDAMENTAL

- Phys. and mech. prop. of soil
- Soil classification systems
- Strength stab. & defl. characteristics
- Stresses & displ. in single & multilayered systems
- Soil plasticity
- Soil dynamics
- Mechanical and chemical soil stabilization
- Quicksand
- Stability of slopes, excavations, landslides
- Frost and permafrost
- Ground water
- Experimental techniques and measurements

16 SOIL MECHANICS - APPLIED

- Piling and pile foundations
- Structural foundations
- Bearing capacity of footings
- Earth pressure on structures
- Earth dams
- Wells
- Highways, runways and railways

17 PROCESSING OF METALS AND OTHER MATERIALS

- Application of plasticity theory
- Plastic (chipless) forming processes
- Cutting processes
- Grinding and polishing
- Ultrasonic working, electroerosion & chem. machining
- Combined methods of cutting
- Surface finish
- Powder metallurgy
- Casting
- Resid. stresses due to mat. processing

18 FRACTURE (INCLUDING FATIGUE)

- Brittle fractures
- Ductile fractures
- Fatigue, creep fract. & corrosion fatigue
- Stress corrosion

19 EXPERIMENTAL STRESS ANALYSIS

- Model studies (similitude and scale models)
- Photoelastic methods and materials
- Electrical resis. strain gages & circuits
- Mechanical, optical and other strain gages
- Brittle coating and other surface methods
- X-ray techniques
- Residual stress measurement
- Recording instruments
- Experimental results

20 MATERIAL TEST TECHNIQUES

- Tension, compression, torsion
- Bending
- Combined loads
- Repeated loading and fatigue
- Thermal fatigue
- Dynamic loading, impact, etc.
- Friction, wear
- Corrosion and weathering
- Hardness
- High temperature
- Low temperature
- Nondestructive testing
- Testing machines

21 PROPERTIES OF ENGINEERING MATERIALS

- Iron, steel and cast iron
- Copper and copper alloys
- Aluminum and aluminum alloys
- Magnesium and magnesium alloys
- Titanium and titanium alloys
- Molybdenum and molybdenum alloys
- Other metals and alloys
- Wood, wood products, paper, etc.
- Adhesives
- Cement, concrete, refractories, etc.
- Cermets
- Glass
- Organic plastics and polymers
- Rubber and elastomers

22 STRUCTURES: SIMPLE

- Statically indeterminate struct., limit analysis etc
- Reinforced constructions
- Prestressed construction
- Sandwich construction
- Two and three dimensional frames
- Arches
- Foundations
- Thermal stresses in structures
- Residual stresses in structures
- Shock resistant structures
- Experimental techniques and measurements

23 STRUCTURES: COMPOSITE

- Bridges
- Dams and spillways
- Tunnels
- Containment structures
- Pressure vessels
- Piping systems
- Ground vehicle structures
- Ground military structures
- Naval structures
- Aircraft structures
- Space vehicle structures

24 MACHINE ELEMENTS AND MACHINE DESIGN

- Cams
- Kinematics of gears
- Gears and gear trains
- Springs
- Couplings and clutches
- Keys and splines
- Interference fits and autofrettage
- Chains and cables
- Linkages
- Mechanisms

25 FASTENING AND JOINING METHODS

- Screws, bolts, nuts and accessories
- Riveting, setting and staking
- Welding with pressure and ultrasonically
- Gas, arc and thermit welding
- Brazing and soldering
- Adhesives and adhesive bonded joints

MECHANICS OF FLUIDS

26 RHEOLOGY

- Continuum theory
- Statistical theory
- Molecular theory and mechanism
- Nonnewtonian flow
- Volume viscosity
- Normal stresses
- Secondary flow
- Flow birefringence
- Flow instability
- Colloids and suspensions
- Experimental techniques and measurements

27 HYDRAULICS

Phys. prop. of liq. (viscosity, surf. tens., etc.)
Orifices, nozzles, valves and gates
Weirs, dams, spillways
Pipe flow
Open chan., backw. curves & hydr. jump
Flow around submerged bodies
Cavitation
Experimental techniques and measurements

28 INCOMPRESSIBLE FLOW

Nonviscous flow
Viscous flow
Potential flow
Secondary flow
Two phase flow
Jets
Unsteady flow

29 COMPRESSIBLE FLOW (CONTINUUM AND NONCONTINUUM FLOW)

Subsonic flow
Transonic flow
Supersonic flow
Hypersonic flow
Shock waves
Condensation in high speed flow
Rar. gas dyn. (slip & free mol. flow)
Jets, nozzles and diffusers
Unsteady flow

30 BOUNDARY LAYER

Laminar boundary layer, incompressible
Turbulent boundary layer, incompressible
Thermal boundary layer, incompressible
Compressible boundary layer
Boundary layer stability
Transition and separation
Boundary layer control
Boundary layer shockwave interaction
Boundary layer with chemical reaction
Unsteady boundary layer
Experimental techniques and measurements

31 TURBULENCE

Homogeneous turbulence, incompressible
Homogeneous turbulence, compressible
Shear flow in boundary layer
Shear flow in jets
Shear flow in wakes
Diffusion and heat transfer in turbulence
Experimental techniques and measurements

32 AERODYNAMICS

Airfoils (including hydrofoils)
Wings
Pressure distribution on airfoils and wings
Control surfaces
Highlift devices
Drag and interference
Performance
Flight path and trajectories
Static stability
Dynamic stability
Gust loads and buffeting
Icing

33 VIBRATION AND WAVE MOTION IN FLUIDS

Vibration in fluids
Theory of wave motions
Finite amplitude waves
Gravity waves
Capillary waves
Pressure waves
Interface phenomena
Hydraulic jump
Waves in ducts and in open channels
Water hammer and surge
Explosion hydrodynamics
Impact between solids and fluids
Experimental techniques and measurements

34 FLUID MACHINERY

Reciprocating pumps
Cascades of airfoils
Hydraulic turbines
Centrifugal fans, pumps and compressors
Axial fans, pumps and compressors
Mixed-flow compressors
Propellers acting on liquid
Propellers acting on gas
Helicopter rotors

35 FLOW AND FLIGHT TEST TECHNIQUES AND MEASUREMENTS

Velocity and acceleration measurements
Pressure measurements
Rate of flow measurements
Viscosity measurements
Optical observations and measurements
Subsonic wind tunnels and measurements
Transonic supers. & hypers. wind tun. & meas.
Wind tunnel corrections
Shock tubes
Flight testing techniques and instruments

HEAT

36 THERMODYNAMICS

Fundamentals of thermodynamics
Thermodynamic cycles and systems
Thermodyn. prop. of gas. & gas. mixt.
Kinetic theory of gases & gas. mixt.
Thermodyn. prop. of liq. & liq. mixt
Kinetic theory of liquids
Thermodynamics of metallurgy
Thermodyn. of low temp., second sound
Irreversible thermodynamics
Heat pumps, refr. and air cond.
Temperature measurement
Experimental techniques and measurements

37 HEAT AND MASS TRANSFER

Conduction
Forced convection
Heat transfer in liquid metals
Gravity convection (free or natural)
Heat transfer in gases at high velocity
Heat transfer in gases at low density
Mass transfer cooling
Heat radiation
Boiling, evap., condensation & sublimation
Heat exchange & heat transfer equip.
Boilers
Regenerators
Mass transfer, theory & equip.
Experimental techniques and measurements

38 COMBUSTION

Flammability and ignition
Flame prop. stabil., flashback & blowoff
Kinetics and mechanism of combustion
Unsteady combustion & comb. acoustics
Thermodyn. & heat transfer aspects of comb.
Laminar and turbulent flames and fuel jets
Burning of liquid and solid fuels
Burning of propellants and explosives
Combustion in boilers and furnaces
Combustion in engines and rockets
Experimental techniques and measurements

39 PRIME MOVERS AND PROPULSION DEVICES

Steam engines and turbines
Internal combustion engines, reciprocating
Gas turbines
Combustors
Afterburners
Rocket motors
Jet engines
Nuclear power systems
Ionic, electronic and photonic propulsion
High energy fuels
Experimental techniques and measurements

COMBINED FIELDS AND MISCELLANEOUS

40 MAGNETOHYDRODYNAMICS

Ionized gases (continuum M. H.)
I. g. arcs and arcs stabilization (discontinuum M. H.)
Magnetohydrodynamics of liquids
Experimental techniques and measurements

41 AEROELASTICITY

General theory of flutter
Flutter coefficients and tables
Flutter of wings, tails and control surfaces
Flutter of propellers and rotors
Panel flutter
Aerod. excitation of turbo mach. blades
Aerodynamic excitation of structures
Nonclassical flutter problems (nonpot. flow, etc.)
Static aeroelast. (diverg., control surf. reversal)
Buffeting and gust response
Aerothermoelasticity
Aeroelastic effects on flight stability
Experimental techniques and measurements

42 AERONAUTICS

Airplanes
Seaplanes and flying boats
Helicopters
Gliders
Balloons and airships
Parachutes

43 ASTRONAUTICS

Space trajectories
Rockets and missiles
Satellites
Space vehicles
Special space vehicle propulsion
Astrophysics

44 BALLISTICS, EXPLOSIONS

Detonation
Interior ballistics
Explosions, terminal ballistics
Explosion hydrodynamics
Metallurgical and material aspects
Guns
Experimental techniques and measurements

45 ACOUSTICS

Wave propagation in acoustics
Sound diffraction refr. refl. & dispersion
Sound absorp., attenuation & acoust. prop. of mat.
Sound generation
Aerothermoacoustics
Ultrasonics
Sound in real phys. solids, propagation in crystals

46 MICROMERITICS

Physical properties of particles
Shape, size distr. of particles & meas.
Fine grinding
Sieving and grading
Charact. of packings, beh. of part. under press.
Dynamics of small particles
Transport of part. by liq. & high visc. fluids
Sprays and drop size
Atomization
Transport of particles by gas, dust cloud
Collection & separation of particles from air
Experimental techniques and measurements

47 POROUS MEDIA

Fundamentals of fluid flow in porous media
Seepage, infiltration
Two phase flow in porous solids
Elastic behaviour of liquid filled solids
Plastic behaviour of liquid filled solids
Dynamical aspects of liquid filled solids
Reservoir engineering (steady state)
Reservoir engineering (transient)
Well logging
Experimental techniques and measurements

48 GEOPHYSICS, HYDROLOGY, OCEANOGRAPHY AND METEOROLOGY

Seismology
Plasticity in geophysics
Heat transfer in geophysics
Exp. meth. & meas. in geophysics
Hydrology
Oceanography (currents, waves, etc.)
Exp. meth. & meas. in hydrol. & oceanogr.
Dynamic meteorology
Thermodynamics of the atmosphere
Solar energy and its utilization
Synoptic meteorology and climatology
Appl. meteorology (eng. & indust. applications)
Exp. techn. & meas. in meteorology

49 NAVAL ARCHITECTURE AND MARINE ENGINEERING

Ship resistance
Ship motion
Hull impact
Hydroelasticity (flutter, divergence, etc.)
Ship stabilization
Ship propellers
Rudders
Planing surfaces
Submarines
Ship model studies
Exp. techn. & meas. in naval archit.
Marine engineering (mar. prime mov., shafting, e

50 FRICTION, LUBRICATION AND WEAR

Fundamental theory of friction and wear
Hydrodynamic lubrication
Boundary lubrication
Solid film lubrication
Exp. techn. & meas. in lubricants
Hydrostatic bearings
Gas lubricated bearings
Oilless bearings
Journal bearings
Thrust bearings
Hydrodynamic bearings, other
Rolling contact bearings
Gear lubrication
Exp. techn. & meas. in bearings

Analytical Methods in Applied Mechanics

(See also Revs. 9, 10, 28, 29, 37, 43, 44, 102, 120, 226, 287, 384, 397, 558)

1. Legendre, R., On theta-elliptic and zeta-elliptic functions and their application for the calculation of flow around a conical wing (in French), *ONERA Publ.* 91, 73 pp., 1958.

A method for the development of elliptic functions is presented which defines elliptic functions from a different point of view than previous methods which employ the concept of elliptic integral of the first kind. Theta-elliptic functions and their logarithmic derivatives, zeta-elliptic functions, are developed which permit one to define elliptic functions in two different ways.

The main object of this paper is to abandon the use of tables of elliptic functions and also to avoid the use of Jacobi and Weierstrass functions whose complexity camouflages the most important properties of elliptic functions.

An application of theta-elliptic and zeta-elliptic functions in potential flow has been made in order to determine the velocity and pressure field around a conical wing. According to author's method, the inverse solution of the problem is also possible. In each case subsonic flow is considered.

M. M. Stanisic, USA

Book—2. Perron, O., The theory of continued fractions, II: Analytical-function-theoretical continued fractions [Die Lehre von den Kettenbruchen, II: Analytisch-funktionen-theoretische Kettenbruche], Stuttgart, B. G. Teubner Verlagsgesellschaft, 1957, vi + 314. DM 49.

Second volume of this third edition deals with analytical and function-theoretical methods, without assuming too much on the part of the reader. Some knowledge of the gamma-function and of linear differential equations is needed. Old and recent convergence criteria are the main aim. The first four chapters have been reworked and enriched. The last two are not much changed and are even shortened. The book is very useful for the specialist in the subject as well as for the user of the techniques which enter, e.g., the study of mechanical and electrical systems.

Olga T. Todd, USA

Book—3. Khovanskii, A. N., Application of continued fractions and of their generalizations to questions of approximate analysis (in Russian), Moscow, Gosud. Izdat. Tekh. Teor. Lit., 1956, 203 pp. 5.25 rubles.

Continued fractions are generally known as one of the most current expedients for approximating given functions by simpler analytic expressions. The present monograph gives a fine survey of the use of such fractions in numerical analysis.

The volume opens with a brief chapter on the analytic theory of continued fractions. Then comes Lagrange's ingenious method of applying such fractions to the solution of differential equations. Theoretical material is abundantly provided with interesting examples on how to express special transcendents (e.g. the incomplete gamma function, hypergeometric series, etc.) by continued fractions. In the third chapter a formula by Obreschkoff is taken for basis to approximating given functions by fractional expressions. The last chapter is devoted to the author's generalization of continued fractions. This extension, indicated long ago by Euler, consists, in our modern conception, in applying certain matrix operators to given vectors. The method can be used to solve approximately algebraic equations of any degree.

W. A. Nash, USA

Book—4. Chen, K. K., Summation of the Fourier series of orthogonal functions, Peking, Science Press, 1957, iv + 174 pp.

Book is important primarily for the pure mathematician. The author discusses numerous methods and theorems which have been derived in recent years in the field of convergence and summability of series of orthogonal functions. Many theorems proved by the author in earlier papers are now examined from a more general point of view. Moreover he gives several improvements of well-known theorems; e.g., he obtains new criteria for the convergence of a Fourier series and, in the case of a sequence of normal orthogonal functions, he proves that the convergence theorem of Rademacker-Menchoff and the summability theorem of Borgen-Kaczmarz-Menchoff are equivalent. Many theorems concerning normal orthogonal systems of functions, absolute convergence of Fourier series, and absolute Cesàro summability of Fourier series are given. The final chapter is devoted to the theory of Cesàro summability of the Laplace series of hyperspherical functions.

C. S. Meyer, Holland

Book—5. Evgrafov, M. A., Asymptotic estimates and integral functions (in Russian), Moscow, Gosud. Izdat. Tekh. Teor. Lit., 1957, 158 pp. 3.90 rubles.

The value of this fine monograph of a considerable mathematical level lies in that it systematizes and generalizes various procedures of obtaining asymptotic expressions, as found scattered in literature.

The subject is divided in three chapters. First comes a survey of the most current methods given by Euler, Maclaurin, Laplace and others. Central significance falls to the second chapter, devoted to the field of integral functions in their connection with the theory of asymptotic expansions. The last section applies theoretical deductions to obtaining special asymptotic estimates.

Volume is written in the style of rigorous mathematical works. Obviously, much of the material is based on original work of the author.

W. A. Nash, USA

Book—6. Kaplansky, I., Hall, M., Jr., Hewitt, E., and Fortet, R., Some aspects of analysis and probability: Functional analysis; A survey of combinatorial analysis; A survey of abstract harmonic analysis; Recent advances in probability theory, New York, John Wiley and Sons, Inc., (Surveys in Applied Mathematics, Vol. IV), 1958, xi + 243 pp. $9.00.

A four-part work which, under the general title of Some Aspects of Analysis and Probability, concentrates on up-to-date developments in the fields of functional analysis, abstract harmonic analysis, combinatorial analysis, and probability theory.

This monograph, published as part of a five-volume series, was prepared under the editorial direction of Applied Mechanics Reviews. Preparation of the material was under the sponsorship of the Office of Naval Research, U. S. Navy.

Ed.

Book—7. Gnedenko, B. V., and Khinchin, A. Ya., An elementary introduction to the theory of probabilities (in Russian), 4th ed., Moscow, Gosud. Izdat. Tekh. Teor. Lit., 1957, 144 pp. 2.20 rubles.

This is the fourth edition of a book originally published in 1945. It has been necessary, in the stormy development of industry and economy in USSR, that many leading persons in various sections acquire an adequate knowledge in the field of applied probability and mathematical statistics. The present book by renowned Russian savants solves masterfully the difficult task of presenting material to possibly widely varying classes of people whose mathematical level is not beyond that of elementary schools.

The paperbound volume is divided into two main parts. The first explains in its six chapters the current elements of probability, including the classical Bernoulli theorem; the remaining section consists also of six chapters devoted to the study of incidental processes. Theoretical deductions are abundantly illustrated on numerous instructive examples.

W. A. Nash, USA

Book—8. Flugge, S. (edited by), Encyclopedia of physics, Mathematical methods II [Handbuch der Physik, Mathematische Methoden II]. Berlin, Springer-Verlag, 1955, vii + 520 pp. DM 198.

This volume consists of five independent chapters:

I. Algebra by G. Falks (116 p.) covers the standard topics of a course in modern algebra, such as matrices, ring and groups. An appendix relates the Poisson bracket formulation of mechanics to algebra.

II. Geometry by H. Tietz (81 p.) covers topics in analytical projective and differential geometry. It includes the usual vector analysis (through the integral theorems), tensors and spinors. The last section relates the subject to mechanics through contact transformations.

III. Functional analysis by I. N. Sneddon (151 p.) deals mainly with the various integral transforms and their applications. There is a brief discussion of such underlying concepts as abstract space and the theory of distributions. ("An introduction to Fourier analysis and generalized functions" by M. J. Lighthill, Cambridge, 1958, is too recent to be cited).

IV. Numerical and graphical methods is by L. Collatz (122 p.). The first section describes the construction of slide rules and nomographs. The remainder discusses the numerical solution of (1) algebraic and transcendental equations; (2) differentiation, interpolation and integration; (3) initial-value problems for ordinary and partial differential equations; (4) boundary and eigenvalue problems for ordinary and partial differential equation; and (5) integral and functional equations.

V. Modern computers by H. Buckner (28 p.) gives a brief account of analog and digital computers.

Chapter III is in English, the rest are in German. The physical format is excellent. Reviewer recommends the book as essential to technical libraries. It should be very useful to teachers planning courses. While all engineers who use mathematics extensively should examine this volume carefully, the choice between it and a number of smaller books dealing with individual subjects is a personal decision. In particular, chapter III will be hard to match. W. Squire, USA

Computing Methods and Computers

(See also Revs. 8, 35, 221, 384, 560)

9. Plainevaux, J. E., Graphical determination of the Stieltjes integrals (in French), *Acad. R. Belg. Bull. Cl. Sci.* **44,** 3, 217–229, 1958.

The Stieltjes integral $\int f(t)\,dh(t)$ appearing in mass, moment of inertia, and, in fact, in any "weighted average" computation, is graphically transformed very simply by changing the schedule of the nonlinear cumulative distribution $h(t)$ to a linear one such that the integral can then be evaluated by use of a planimeter. Integrals of products of functions are amenable to similar treatment by transformation to Stieltjes integrals by defining $h(t)$ to be the integral of one of the functions. Reviewer believes that this has its greatest advantage in graphical integration in frequently occurring cases when function has an infinity while its integral does not. When many integrals with respect to a fixed distribution $h(t)$ are to be computed, another advantage results from the use of specially scaled graph paper.

Several examples are given. M. L. Juncosa, USA

10. Good, I. J., On the numerical solutions of integral equations, *Math. Tables Aids Comput.* **11,** 82–83, 1957.

One of the standard methods of solving linear integral equations with a kernel $K(s, t)$ involves replacing the integral operation by a finite sum in the sense of numerical quadrature. The method leads to the inversion of a matrix M, the elements of which are computed from the values of $K(s, t)$ at certain mesh points. It is proposed to keep the order of the matrix relatively small and to construct from the inverse matrix an approximation to the inverse kernel by a process of smooth interpolation. The approximation can be used as a good guess for iterative procedures.

H. Buckner, USA

Courtesy of Mathematical Reviews

11. Picone, M., The automation of calculus and the progress of mathematical analysis (in Italian), *Ric. sci.* **28,** 4, 697–717, Apr. 1958.

The present paper, with examples taken from works completed at the Istituto Nazionale per le Applicazioni del Calcolo, seeks to prove that the great possibilities of numerical calculations made available to-day by automatic computers may unveil to the mathematician interesting facts about the theory of pure mathematical analysis. A procedure of numerical analysis is described which is apt to give the minimum, in a given field, of a real functional, and analytical foundations are given which—with the increasing power of automatic computers—should make it practical to apply the procedure described to the numerical solution of big systems of algebraic linear equations.

From author's summary

12. Woolett, E. R., Subtabulation with special reference to a high-speed computer, *Quart. J. Mech. appl. Math.* **11,** 2, 185–195, May 1958.

The method of Comrie and Bower for subtabulating a function by use of bridging differences is generalized to cover all sub-intervals where the procedure gives exact pivotal values. Two other methods are given; one uses leading differences and the other corrections to all odd orders of differences. The merits of the three methods for use with an automatic computer are discussed. It is shown that any desired accuracy can be obtained even when the pivotal values are not built up exactly. Author's method can be applied to all subtabulation ratios including those that are nonintegral or even irrational. Various worked examples are given.

From author's summary by A. S. Householder, USA

13. Pawlak, Z., and Wakulicz, A., Use of expansions with a negative basis in the arithmometer of a digital computer (in Russian), *Bull. Acad. Polonaise Sci. Cl. III* **5,** 233–236, 1957.

The authors suggest the use of a negative basis for representing numbers in a computer in order to obtain a uniform treatment of all the bits within the arithmetic unit. The possibility of such a representation is based on the theorems that every real number α possesses an expansion with an integer basis $g < -1$ and that this expansion is unique if it is finite or in the case of infinite expansions, if the number α is not of the form

$$\alpha = E(g^k/(1-g)) + Cg^{k+1} \quad (E = \pm 1, C, k \text{ integers}).$$

The numbers satisfying this relation have two distinct infinite expansions. The algorithms for addition, subtraction, multiplication and division are discussed. These operations are somewhat more complicated than in the case of a positive basis, particularly the division. Further, the 0 in the case of fixed point numbers is not at the center of the interval, thus avoiding the difficulty of "+0" and "−0."

The authors claim that since their system allows to treat all the bits of a number uniformly (no special sign position) the number of circuits in the arithmetic unit with different functions can be reduced. U. W. Hochstrasser, USA

Courtesy of Mathematical Reviews

14. Frankel, S. P., The logical design of a simple general purpose computer, *IRE Trans.* EC-6, 5–14, 1957.

Techniques used by the logical equation school of computer designers are explained by developing the logical design of the

LGP-30, medium-speed computer. It uses a magnetic drum to store information and to supply certain timing signals which control the sequencing of operations. Fifteen toggles (or flipflops) determine the internal state of the computer. Each toggle is a bistable device controlled by two input lines, one for turning it on and one for turning it off. The signals on these lines are supplied from a logical net consisting of diode circuitry whose inputs are signals from the magnetic drum and the toggles themselves. Logical functions represented by this diode net thus control the sequence of states of the toggles and hence determine the behavior of the computer. Logical design consists of the derivation of the logical functions of the diode net and is the subject of this paper.

A list of sixteen instruction types, such as add, subtract, record on the drum, etc., is provided as a starting point for the logical design. Each instruction type is broken down into elementary operations which are described in terms of transitions of the toggles. These transitions are realized by including corresponding terms in the logical functions which will produce them. The entire set of logical functions is thus formed, term by term, during a detailed analysis of the instructions. D. E. Muller, USA

Courtesy of Mathematical Reviews

15. Wagner, H. M., A lemma for automatic optimum programming on the IBM 650, *Math. Tables Aids Comput.* **11,** 101–104, 1957.

The lemma is as follows: Let n and k be positive integers. Then the sequence (a) $1, 1+n, 1+2n, 1+3n, \ldots$ modulo $(nk+1)$ completely exhausts the numbers $(1, 2, 3, \ldots, nk+1)$ before repeating any number in the sequence; similarly for (b) $1, 1+n, 1+2n, 1+3n, \ldots$ modulo $\lceil n(2k+1)+2 \rceil/2$, where n is even; and (c) $1, 1+n, 1+2n, 1+3n, \ldots$ modulo $\lceil n(2k+1)+1 \rceil/2$, where n is odd.

In writing an optimized program for a computer, the problem is to locate the instructions in the store (usually a drum) so that they become available to the read-out device just as the machine needs them. It is easy to do this for the instructions in the first part of a program, but as the store is filled, it becomes increasingly difficult to do it later. This paper describes a technique, suggested by the lemma, for placing all the instructions optimally. The actual rearrangement of a program with instructions and data in consecutive locations to one where they are arranged optimally is done by the computer. C. C. Gotlieb, Canada

16. Worthy, W. D., Use of interpretation routines on a general-purpose digital computer for the design of linear and non-linear control systems, *Proc. Instn. Elec. Engrs.* (*B*) **103,** Suppl. 1, 1956; 68–76.

A convenient yet versatile digital computer program is described which facilitates the design of control systems whose behavior may be described by a set of simultaneous ordinary differential equations. This program is most easily applied to the usual case in which the first derivative of each variable may be expressed as the sum of relatively few linear terms and a constant. The equations are integrated numerically by the computer using a second-order version of the Runge-Kutta integration process which requires two evaluations of the derivatives per step. Machine instructions may be included among the coefficients of terms in the equations so as to permit the formation of nonlinear terms if they are required to describe the system. Various options allow the user to make changes in one or more of the coefficients and repeat the integration process. Graphical or printed output may be obtained for any variable.

This program is compared with mechanical and electrical differential analyzers as regards speed, accuracy, convenience and versatility. D. E. Muller, USA

Courtesy of Mathematical Reviews

17. Newman, E. A., and Wright, M. A., An automatic floating-address machine, *Proc. Instn. Elec. Engrs.* (*B*) **103,** Suppl. no. 1, 1956; 134–137.

In order to speed use of a hierarchy of storage in a general-purpose digital computer, authors have included in the design of the T. A. C. T. (Three-address Code machine, Tagged) a procedure for storing names of data along with the data. These "tags" are not "floating addresses" in the classical computer sense in that they are names for data only, and not instructions. The machine has sixteen 48-bit words of high-speed storage of a type not specified, and 1024 words of magnetic drum storage. Each word consists of a 36-bit data portion and a 12-bit tag. On processing an instruction, the machine searches the high-speed memory for the needed tags, and upon finding them sends the corresponding data to the arithmetic unit. Results are stored similarly in that location containing a specific tag. When a tagged variable is not in the high-speed memory, an arbitrary word in that memory is replaced by the correct word from the magnetic drum memory. Intuitively this process would appear to speed up performance of operations when instructions are stored sequentially on the drum. Logical diagrams are included for the circuitry involved in manipulation of the tags. J. W. Carr, III, USA

Courtesy of Mathematical Reviews

18. Ridge, S. E., Use of electronic digital computers in highway engineering, *Civ. Engng. N. Y.* **28,** 5, 48–51, May 1958.

19. Belzer, J., Solving spiral bridge geometrics by computer, *Civ. Engng. N. Y.* **28,** 5, 52–54, May 1958.

20. Chafets, E. M., and Plaxe, E., Bridge piers designed by computer, *Civ. Engng. N. Y.* **28,** 5, 55–58, May 1958.

21. Zahler, C. W., Designing steel bridges by computer, *Civ. Engng. N. Y.* **28,** 5, 59–61, May 1958.

22. Veletsos, A. S., Some applications of a digital computer in structural research, *Civ. Engng. N. Y.* **28,** 5, 62–65, May 1958.

23. Cozzone, F. P., High speed computers in the aircraft industry, *AGARD Rep.* 130, 7 pp. + 3 tables + 3 figs., May 1957.

Analogies

(See Revs. 107, 310)

Kinematics, Rigid Dynamics and Oscillations

(See also Revs. 36, 104, 190, 399, 498, 503)

24. Subbotin, A. F., Investigation of the stability of motion of a wheel pair in relation to its derailment (in Russian), *Trudi Tashkentsk. in-ta zh.-d. transp.* no. 5, 142–156, 1956; *Ref. Zh. Mekh.* no. 4, 1957, Rev. 3956.

It follows from analysis of the equilibrium equations that the transverse displacement and derailment of a wheel pair are relieved by the presence of a transmitted braking or thrust torsional moment, by boxing the wheel pair. The possibility of leaving the rails increases with increase of the redistribution of the vertical load between the wheels during motion along the curve and on the points. Derailment is possible at a comparatively long action of the transverse force. If the axis is unloaded and there are no transverse forces, then in all cases slipping down of the flange of the wheel is guaranteed. K. S. Kolesnikov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

25. Kovtun, D. G., Equations for the movement of a wheel with a spring-mounted mass along an elastically deforming curve (in

Russian), *Trudi Khar' kovsk. in-ta inzh. zh.-d. transp.*, no. 26, 190–196, 1956; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1535.

Equations were obtained for the movement of a rigid wheel with a spring-mounted mass along an elastically deforming curve. Where the movement in the horizontal plane appears to be steady, the movement of the center of inertia of the wheel in the vertical plane is described by means of an equation of a quasi-harmonic type. K. S. Kolesnikov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

26. Sizov, M. B., Dynamics of the relative motion of a heavy particle on lines rotating about a vertical. Dynamics of the relative motion of a heavy particle over smooth curvilinear links rotating about the vertical (in Russian), Mekhanika (MVTU **50**) Moscow, Oborongiz, 1956, 182–236; *Ref. Zh. Mekh.* no. 4, 1957, Rev. 3866.

The derivation is given of the equation of motion of a heavy particle slipping over an arbitrary source of double curvature rotating about the vertical straight line. The equation obtained is used for the selection of a number of particular examples, while the angular velocity of rotation is either taken as constant or determined by the given function of the variable parameter which fixes the position of the particle on the curve. Certain problems connected with the stability of the position of relative equilibrium of a heavy particle on a rotating curve are examined. The equations of motion of a heavy particle over a rough rotating curve are formulated and integrated in particular cases.

L. N. Sretenskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

27. Steffensen, J. F., On the problem of three bodies in the plane, *Mat.-Fys. Medd., Danske Vid. Selsk.* **31,** 3, 18 pp., 1957.

Three bodies with finite masses are assumed to move in a plane, subject to Newton's law of gravitation. By the introduction of suitable auxiliary variables the equations of motion are transformed into a system of differential equations of the second degree, permitting expansion of the unknown quantities in powers of the time t, the coefficients of t^{ν} being calculated by means of a set of recurrence formulas. Sufficient conditions for the convergence of the resulting series are given, and the practical working of the method is illustrated by a numerical example.

E. Leimanis, Canada

Book—28. Leimanis, E., and Minorsky, N., Dynamics and nonlinear mechanics. Some recent advances in the dynamics of rigid bodies and celestial mechanics; the theory of oscillations, New York, John Wiley and Sons, Inc., (Surveys in Applied Mathematics, Vol. II), 1958, xii + 206 pp. $7.75.

The first part of this book surveys modern analytical progress in the treatment of classical dynamical problems which are assuming increasing importance in today's technology. The second part outlines the current state of the art in the analysis of nonlinear oscillating systems and points the way to future developments in this field, which is receiving such great emphasis in control system engineering and other technical areas.

This monograph, published as part of a five-volume series, was prepared under the editorial direction of Applied Mechanics Reviews. Preparation of the material was under the sponsorship of the Office of Naval Research, U. S. Navy. Ed.

29. Giangreco, E., and La Tegola, A., Dynamic application of the fixed point method (in Italian), G. Gen. civ. **96,** 2, 103–111, Feb. 1958.

Authors determine the lowest frequency of the free oscillations of a structure by means of an iterative method. Three examples are worked out numerically. O. Bottema, Holland

30. Bishop, R. E. D., and Johnson, D. C., On damped free vibration with particular reference to systems having nearly-equal natural frequencies, *Aero. Quart.* **9,** 1, 71–95, Feb. 1958.

Authors consider the free vibration of linear systems subject to damping. General equations for system with n-degrees of freedom are developed; approximate solution is then presented for case of "light damping" (all modes oscillatory). Coupling of principal modes is found to occur in this case, confirming Southwell's findings. Solution is illustrated by example of torsional vibrations of shaft with two rigid flywheels, both under "light" and "heavy damping" (at least some modes aperiodic). Approximate theory is shown to be invalid for nearly equal natural frequencies. A solution for this problem is illustrated for a specific example involving two degrees of freedom only. N. A. Weil, USA

31. Krasovskii, N. N., The problem of the conversion of the theorems of A. M. Lyapunov's second method for investigating the stability of motion (in Russian), *Uspekhi mat. Nauk* **11,** 3, 159–164, 1956; *Ref. Zh. Mekh.* no. 4, 1957, Rev. 3894.

Examination of the differential n-system in the normal form with autonomous right-hand side of the class 0^m ($m > 1$). A completely smooth scalar function v is constructed, identically disappearing at a certain proximity to the given point, and also disappearing outside the tube of the trajectory passing through this proximity and strictly decreasing along the trajectory from the tube. With the aid of the selection of functions v, the theorems of Barbashin and Masser regarding the conversion of the theorems of the direct Lyapunov method in the case of asymptotic stability are re-demonstrated elegantly and the reversibility of the third Lyapunov theorem regarding the instability of unsteady motion is determined. A number of allied problems are touched upon.

Yu. S. Bogdanov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

32. Shvartsman, G. A., Dynamic conditions of the plane parallel motion of a solid body (in Russian), *Trudi Kievsk. tekhnol. in-ta legkoi prom-sti* no. 7, 161–166, 1955; *Ref. Zh. Mekh.* no. 4, 1957, Rev. 3872.

Author establishes that a free solid body may effect plane parallel motion only parallel to the plane of its material symmetry and only in the case when the external forces reduce to one force or one couple lying in this plane in the case of completely specific initial conditions. L. N. Chekhova

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Instrumentation and Automatic Control

(See also Revs. 16, 328, 329, 334, 351, 491)

33. Sutcliffe, H., The relations between zero errors and bandwidths for different types of rate-of-turn meters, *Aero. Quart.* **9,** 2, 131–146, May 1958.

In a conventional rate-of-turn measuring gyroscope the necessity to use a displacement transducer results in an appreciable zero error when a rapid response is required. Other types of instrument, employing alternating forces and force transducers, are also shown to have a relation between error and response time. An assessment is made of these relations and conclusions are reached concerning the relative merits of the different types. The results are given in terms of the estimated rate errors as function of bandwidth. From author's summary

34. Brown, W. M., Analysis of discrete linear systems, *J. Soc. indust. appl. Math.* **5,** 4, 206–224, Dec. 1957.

Paper develops, from fundamentals, theory of linear sampled-data systems, including correlation theory for random inputs. B

restricting attention to sampling instants, analytical rigor is achieved simply, in contrast to continuous analysis; it should thus appeal to engineers seeking a direct approach to sampled-data theory.

N. Ream, England

35. Stein, A. H., Analysis of closed loop systems, *Calc. Automat. y Cibernet.* **5,** 14, 11–22, 1956.

An analogy between analog and digital computers is studied. Author starts with the example of a simple closed loop control system and sets up its transfer function. He then turns to those special digital computers which receive and deliver a continuous signal; e.g., real time computers for control purposes. He assumes that the computer consists of a modulator of impulses, a digital filter, a demodulator and a carrier of pulses. The input signal is sampled at regular intervals; the samples are quantized and digitalized for computer requirements. Transfer functions of the elements are set up and linked together.

H. Buckner, USA

Courtesy of Mathematical Reviews

36. Duncan, W. J., Impulsive and indicial admittances of simple dynamical chains, *Aero. Quart.* **9,** 1, 1–16, Feb. 1958.

A dynamical chain is defined as a system consisting of masses each with one degree of freedom and each connected with its two neighbors only. The response of such systems to a unit impulse and to a unit step is calculated for the cases when the first and last masses are or are not connected to fixed points. Explicit formulas are given for systems with one, two, or three masses.

A. I. van de Vooren, Holland

37. Bose, A. G., A theory of nonlinear systems, Mass. Institute of Technol., Res. Lab. Electronics, Tech. Rep. 309, i + 58 pp., 1956.

The Wiener theory of nonlinear system characterization is described and some of its important concepts are discussed. Following these lines, a theory is developed for the experimental determination of optimum time-invariant nonlinear systems. The systems are optimum in a weighted mean-square sense in which the weighing function is available.

The design of nonlinear systems is regarded as the problem of mapping the function space of the past of the input onto a line that corresponds to the amplitude of the filter output. By choosing a series expansion for this mapping operation that partitions the function space into nonoverlapping cells, an orthogonal representation for nonlinear systems is obtained that leads to convenient apparatus for the determination of optimum systems. General methods are described for applying this theory to the determination of systems that have a performance superior to that of given linear or nonlinear systems. A criterion is established relative to which two systems are defined as "nearly equivalent" and the approximation of nonlinear systems by linear and simple nonlinear systems is discussed. The theory is extended to include the problem of multiple nonlinear prediction, and apparatus for the determination of optimum predictors is indicated.

From author's summary

38. Skachkoff, B. N., On the stability of a class of nonlinear systems of automatic regulation (in Russian with English summary), *Vest. Leningrad Univ.* **12,** 1, 46–56, 208, 1956.

The author considers a control system characterized by the equations

$$\begin{aligned} \dot{\eta}_1 &= a_{11}\eta_1 + a_{12}\xi \\ \dot{\eta}_2 &= a_{21}\eta_2 + a_{22}\xi \\ \dot{\xi} &= f(\sigma),\ \sigma = a_{31}\eta_1 + a_{32}\eta_2 - \xi, \end{aligned} \qquad [1]$$

where the a_{ij} are constants, $a_{11} < 0$, $a_{21} < 0$, and $f(\sigma)$ satisfies $f(\sigma) = 0$ for $\sigma = 0$ and $\sigma f(\sigma) > 0$ for $|\sigma| > 0$ in addition to the usual continuity and unicity assumptions. Lur'e ["Some nonlinear problems of the theory of automatic regulation," Moscow-Leningrad, Gostehizdat, 1951] has shown that under certain conditions on the parameters of [1] there exists a positive definite function

$$V = \int_0^\sigma f(\sigma)\,d\sigma + B_1\dot{\eta}_1^2 + B_2\dot{\eta}_1\dot{\eta}_2 + B_3\dot{\eta}_2^2,$$

where the last three terms represent a positive definite quadratic form, such that $\dot{V}$ is negative definite by virtue of [1]. By using Lur'e's result and a theorem due to Pliss [*Dokladi Akad. Nauk USSR (N.S.)* **103,** 17–18, 1955] the author obtains a set of sufficient conditions, too detailed to reproduce here, for the asymptotic stability in the large of the trivial solution of [1].

L. A. Zadeh, USA

Courtesy of Mathematical Reviews

39. Ostrovsky, G. M., The application of nonlinear corrective networks in second-order automatic control systems (in Russian), *Automation and Remote Control* **17,** 11, 979–984, Nov. 1956. [Translation of *Avtomatika i Telekhanika* **17,** 11, 1095–1101, by Consultants' Bureau Inc., New York, N.Y.].

Author treats the problems of improving the control performance of linear second-order servosystems by means of introducing special nonlinear networks, e.g., when the equation of motion is of this form: $\ddot{e} + F(e, \dot{e}) + e = 0$. The function $F(e, \dot{e}) = f(e)\cdot\dot{e}$ represents "the optimum transient response" (when the transient-response time is a minimum), supposing that the function $f(e)$ is subjected to the limitation $c \leqslant f(e) \leqslant b$. The equation $\ddot{e} + b\dot{e} + e = 0$ is examined when $b \geqslant 2$ (real roots) and $b < 2$ (complex roots). The integral curves are plotted. As an example, a servosystem is examined with equation describing its motion $I\ddot{\theta}_0 + f\dot{\theta}_0 = ke$, where I is the moment of inertia, f the coefficient of liquid friction at the output shaft of the motor, k the gain, and $e = \theta_1 - \theta_0$ the error. The obtained results are discussed.

D. Raskovic, Yugoslavia

40. Ludwig, G., and Rollnik, H., Theory of control systems with time-variable control strength (in German), *ZAMM* **37,** 11/12, 457–470, Nov./Dec. 1957.

The existing general theory of servomechanisms is generalized so as to cover systems where the control strength varies with the time in such a way that the system is brought into the prescribed final state within a finite period of time, namely, the case governed by equation $P\left(\frac{d}{dt}\right)(t\epsilon) + Q\left(\frac{d}{dt}\right)(\epsilon) = n$ [where $\epsilon = \epsilon(t)$, $n = n(t)$, $P(z) = \sum p_\nu z^\nu$, $Q(z) = \sum q_\mu z^\mu$, $\nu = 0, \ldots, n$; $\mu = 0, \ldots, m$] is treated. The problem is solved by using a general Laplace transformation. For the case when the differential operators are polynomials of any finite degree, rigorous solutions in integral form are given. The asymptotic expansion and power series are derived. The stability conditions of the system are also derived. The way of the integration in the case of $P(z)$ with the zero points is plotted for several cases.

D. Raskovic, Yugoslavia

41. Noton, G. J., and Turnbull, D. E., Some factors influencing the stability of piston-type control valves, Instn. mech. Engrs., Preprint, 15 pp., 1958.

A very thorough analysis with accompanying report of good experimental correlation. Mechanism of instability discussed involves only the dynamics of inertial load and spool and normal incompressible flow characteristics and is not related to oil compressibility effects or resonances in the connecting pipes.

R. M. Stewart, USA

42. Liebaut, M. A., Automatic temperature regulation (in French), *Mem. Soc. Ing. civ. Fr.* **110,** 6, 531–553, Nov./Dec. 1957.

Author surveys in a scholarly manner the various aspects of automatic temperature regulation. Six temperature ranges are set up to cover the normal exigencies of industry conveniently (the temperature unit, although nowhere given, is evidently Centigrade). Five types of temperature-generating aggregates are introduced upon the basis of their mechanical and physical operating principles. Temperature-regulating devices are then described and the inherent advantages and disadvantages of instrumentation and circuitry are indicated. The bimetal dilatometer and thermometers utilizing both liquid and gas expansion are discussed, also vapor pressure devices and thermocouples. Special mention is also made of radiation bolometers. Mathematical discourse is applied to a sizeable number of variations employed in the temperature regulation by means of electric servocircuits. Graphs are used for illustration of the algebra. A final synopsis summarizes the applicability of the devices previously covered.

E. L. Eichhorn, USA

Elasticity

(See also Revs. 84, 143, 158, 176, 189, 214, 235, 246, 303, 558)

43. Blackburn, W. S., Second-order effects in the torsion and bending of transversely isotropic incompressible elastic beams, *Quart. J. Mech. appl. Math.* **11,** 2, 142–158, May 1958.

General formulas are obtained for the second-order effects in the deformation of incompressible transversely isotropic elastic bodies. The problem of the second-order torsion and extension of a homogeneous incompressible cylinder, transversely isotropic with respect to its generators, is reduced to the solution of the classical torsion and flexure boundary-value problems, together with another boundary-value problem, involving two complex potential functions. Without solving these, a formula is obtained for the fractional elongation of the cylinder. The problem of the second-order bending of such a cylinder by terminal couples is also reduced to the solution of a single boundary-value problem for two complex potential functions and the classical boundary-value problem for torsion. A general formula is found for the change of length of the line of centroids; and the boundary-value problem is solved for the case of right circular cylinders.

From author's summary by S. E. Kindem, Norway

44. Doyle, T. C., Higher order invariants of stress or deformation tensors, *J. Math. Phys.* **36,** 4, 297–305, Jan. 1958.

The tractability of certain problems in nonlinear elasticity is largely due to the circumstance that the elastic specific strain energy of an elastically isotropic medium is expressible with three joint invariants of order zero of the metric tensor of Euclidean 3-space and of the Cauchy-Green deformation tensor. In this paper, author derives a fundamental system of order p of irrational joint invariants of the metric tensor $\mathbf{g}$ and a generic two-index tensor $\mathbf{a}$. Author restricts his attention to a system of order 1 and derives a rational fundamental system of 18 invariants which constitutes the first-order extension of rational system of order 0. Author identifies the generic two-index tensor with the stress tensor and with the deformation tensor, which are pertinent to elasticity theory, and he shows the resultant dependencies consequently imposed upon the invariants of orders $\leqslant 2$.

From author's summary by G. Sestini, Italy

Book—45. Lur'e, A. I., Three-dimensional problems of the theory of elasticity (in Russian), Moscow, Gostekhizdat, 494 pp., 1955; *Ref. Zh. Mekh.* no. 4, 1957, Rev. 4562.

This book is to a considerable extent based on the author's own investigations. Great attention is devoted to bringing the solution to a form directly suitable for numerical calculations. A bibliography is given after each chapter.

G. Yu. Dzhanelidze

Courtesy Referativnyi Zhurnal, USSR

Translation, courtesy Ministry of Supply, England

46. Kogan, S. Ya., A solution of the three-dimensional problem in the theory of elasticity by the alternation method of Schwartz (in Russian), *Izv. Akad. Nauk SSSR, Ser. geofiz.* no. 3, 307–319, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3345.

The convergence of the alternation process in the solution of the first problem of the theory of elasticity is examined. It is assumed that the vector of the external load for the surface S in the region D is continuous everywhere on S excepting on the line $l < S$ where it becomes infinite as $|\log^{\alpha}\delta|$ ($\alpha \geqslant 0$, an integer; δ distance from the point to the line l).

Let T_{2i}, T_{2i+1} be the tensors of the stress in one cycle ($i = 0, 1, 2, \ldots$), constructed by the Schwartz method. It is demonstrated that

(1) The energies of deformation corresponding to the tensors T_{2i}, T_{2i+1} satisfy the inequality

$$E(T_{2i}) > E(T_{2i+1}) > E(T_{2(i+1)})$$

(2) The sequences T_{2i} and T_{2i+1} converge within D to one and the same limiting tensor T.

(3) The limiting tensor T satisfies within D the conditions of equilibrium, the Beltrami equations, and the boundary conditions everywhere on S outside the line l. The proof of this is given by the direct methods of variational calculus.

N. A. Alumyae

Courtesy Referativnyi Zhurnal, USSR

Translation, courtesy Ministry of Supply, England

47. Adkins, J. E., A reciprocal property of the finite plane strain equations, *J. Mech. Phys. Solids* **6,** 4, 267–275, July 1958.

Author considers general nonlinear elasticity equations for plane deformation combined with uniform stretch perpendicular to this plane of incompressible isotropic and transversely isotropic materials. He proves a reciprocal theorem enabling one to convert any solution into another by interchanging undeformed and deformed coordinates. A stronger result is obtained for Mooney materials. Illustrative examples are given.

J. L. Ericksen, USA

48. Godfrey, D. E. R., Generalized plane stress in an elastic wedge under isolated loads, *Quart. J. Mech. Appl. Math.* **8,** 226–236, 1955.

An account is given of the application of Tranter's method of Mellin transforms [title source **1,** 125–130, 1948] to the solution of the equations of generalized plane stress in polar coordinates. Throughout, the author expresses the mean stresses and displacements in terms of the complex potentials introduced by Stevenson [*Phil. Mag.* (7) **34,** 766–793, 1943]. This considerably shortens the formal analysis and leads to solutions for nuclei of force or couple acting at any point of an infinite wedge thereby avoiding the usual tentative approach offered by an Airy stress-function method. The solutions are derived for a wedge with stress-free or rigid boundaries.

I. N. Sneddon, Scotland

Courtesy of Mathematical Reviews

49. Wigglesworth, L. A., Stress relief in a cracked plate, *Mathematika* **5,** 1, 67–81, June 1958.

Maximum stress in circular hole drilled at end of crack is found by conformal mapping and evaluation of series. Author fails to mention that approximation of problem by an elliptical hole with minimum radius of curvature ρ equal to that of drilled hole, and major axis $2c$ equal to total length of hole and crack gives stress concentration of $1 + 2\sqrt{c/\rho}$. This is only 0 to 5% lower than

tabulated values and limiting equation (6.17). Thus author's work further justifies elliptical approximation. See also AMR **9**(1956), 3608.

Erratum: Reference before Eq. (6.16) should be to Eq. (2.2), not (5.22). F. A. McClintock, USA

50. Mura, T., Residual stresses due to thermal treatments, *Fac. Engng., Meiji Univ., Tokyo, Res. Rep.* no. 10, 14–27, 1957.

A method is developed and applied for determining the residual stresses resulting during the quenching operations of heat treatment. The body is divided into two regions during the quenching operation, depending upon the strength at a critical temperature T_0. The outer region of the body, at temperature below T_0, is assumed perfectly elastic; the inner portion of the body, at temperatures above T_0, is assumed perfectly plastic with zero shear stress and zero dilatation. The method is used to calculate the residual stresses in a solid cylinder and ring following the quenching operation for different quenching temperatures and different critical temperatures, T_0.

Reviewer found the introductory sections describing the general method quite clear, but found it difficult to follow the applications of the method in any detail because of the brevity of the paper. A. L. Ross, USA

51. Panarin, N. Ya., Temperature stresses in concrete in the presence of creep (in Russian), *Nauch. tr. Leningr. inzh.-stroit. in-ta* no. 23, 43–54, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3523.

Applying analytical expressions for the rate of creep and time-variation of the modulus of elasticity of concrete, as derived in the work of N. Kh. Arutiunian ["Some problems of the theory of creep," Gostekhizdat, 1952], author, following G. N. Masslow [*Izv. N.-i. in-ta gidrotekhniki* **28,** 1940] represents the component stresses in the form of the product of the function of the coordinates by the time function (coefficient of damping of the stress).

A solution is presented for the known integral equation of the theory of creep by reducing it to a second-order inhomogeneous differential equation with variable coefficients.

Introducing certain simplifications in the expressions, author obtains final calculation formulas for the damping coefficient.

M. A. Zadoyan
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

52. Mura, T., Dynamical thermal stresses due to thermal shocks, *Fac. Engng., Meiji Univ., Tokyo, Res. Rep.*, no. 8, 63–73, Feb. 1956.

Effects of inertia of mass upon thermal stresses are studied. First problem considered is that of semi-infinite solid, initially at uniform temperature, whose surface temperature is given a step increase. Author finds a "shock wave" associated with the inertial effects. Corresponding stresses are to be superposed upon those conventionally calculated without inertial effects. Orders of magnitude of the two sets of stresses are comparable. A second problem, closely related, is also treated. Here a right circular cylinder of infinite length undergoes a step increase of surface temperature. The solution, obtained in terms of infinite series of Bessel functions, poses difficult problems in evaluation. Author concludes that additional terms representing inertial effects are negligible in this case.

Reviewer believes that "shock-wave" phenomenon is not of engineering importance. A step increase of surface temperature is not physically attainable. Auxiliary calculations suggest that achievable rates of temperature rise will generate only inconsequential stress waves. R. E. Newton, USA

53. Sparenberg, J. A., On a shrink-fit problem, *Appl. sci. Res.* (*A*) **7,** 2/3, 109–120, 1958.

Problem of infinitely long elastic tube with shrink or force fit on rigid, frictionless, semi-infinite cylinder is investigated using Fourier transform methods. Contact stress (pressure between members) is given by integral which is solved numerically. Results: (a) Pressure becomes uniform (elementary Lamé theory) at distance of about one cylinder radius from free end. (b) Pressure approaches infinity inversely as square root of distance from free end regardless of tube thickness. (c) For tube thin enough, regions of no contact can occur (negative contact pressure).

E. T. Cranch, USA

54. Mossakowska, Z., Concentrated force in the interior of a transversally isotropic elastic semi-infinite space (in English), *Arch. Mech. stos.* **10,** 2, 233–251, 1958.

The system of Lamé equations for a transversally isotropic body is solved by introducing three displacement functions, each of them satisfying a differential equation of the sixth order. The displacement components are calculated by means of certain differential operations on the functions introduced.

A transversally isotropic elastic semispace bounded by a plane parallel to that of isotropy is considered.

Three different boundary conditions are considered: the plane is free, rigidly fixed, or "simply supported" (that is, the shear stresses and the normal displacements are equal to zero). The load is constituted by a concentrated force applied at an arbitrary point inside the semispace and directed either normally or parallel to the bounding plane. In both cases one displacement function is sufficient. It is expressed by a double Fourier integral. Author succeeds in expressing the displacement and the stress in the form of closed functions. However, in the case of the force parallel to the plane of isotropy and completely fixed bounding plane it was not possible to calculate the Fourier integral.

One numerical example is given.

Z. Kaczkowski, Poland

55. Minassian, R. S., The transverse bending of a prismatic beam in torsion (in Azerb.), *Trudî Azerb. industr. in-ta*, no. 12, 35–51, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3392.

The interaction between bending by a transverse force and torsion is investigated by the nonlinear theory of elasticity for a prismatic beam composed of different elastic materials.

The problem in this form is reduced by the method of the small parameter to five boundary problems referring to a two-dimensional, compound region (cross section of the beam); the possibility of solution of these problems is demonstrated. (See also: A. F. Sharangia, *Trudî Gruz. politekhn. in-ta* no. 2, 153–166, 1955.)

A. K. Rukhadze
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

56. Leonov, M. Ya., Approximate solution of torsion problems (in Russian), *Nauch. zap. in-ta, Mashinoved. i automatiki, Akad. Nauk Ukr. SSR* no. 5, 41–45, 1956; *Ref. Zh. Mekh.* no. 4, 1957, Rev. 4596.

For calculating the tangential stresses occurring during torsion of a solid rod "at points" of the boundary contour Γ of its cross section B, the following approximate formula is derived

$$\tau = G\vartheta' \left(2h - \frac{h^2}{\rho}\right)$$

Here G is the shearing modulus, ϑ' the angle of torsion, ρ the curvature of the contour Γ at the given point A, h the length of the section of the normal at the point A from A to the point of intersection with the mean line of the section, determined as the geometrical locus of the center of the circle belonging to B touching Γ at at least two points.

The estimate of error of formulas [1] given in the paper only for a rod of elliptic section (varying between 0 and 12.5% depending on the ratio of the half-axes of the ellipse) suggests that the for-

mula cannot be extensively applied, since its solution is very approximate. P. P. Kufarev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

57. Bell, J. F. W., Dynamic and static elasticities of solids, *Nature* **181,** 4619, p. 1330, May 1958.

Viscoelasticity

(See also Revs. 51, 114, 144, 239, 240, 243)

58. Eimer, C., Application of the Laplace transformation to rheological computation of prestressed structures (in Polish), *Rozpr. Inzyn.* **6,** 1, 183–200, 1958.

Assuming that the creep function depends on the difference between two arguments $C = C(t - \tau)$ (which is equivalent to the assumption of independence of creep of the age of the concrete at the moment of applying the load), the Laplace transformation is applied to systems of integral equations derived for isostatic and hyperstatic prestressed structures. Thus the problem reduces to the solution of systems of linear algebraic equations, which facilitate considerably the attainment of effective results. The difficulties of inverse transformation are discussed. Possibilities of simplifications are indicated and illustrated by a numerical example of computation of a two-hinge rectangular frame.

Z. Bychawski, Poland

59. Pines, B. Ia., Diffusive creep of solids, *Soviet Phys.-Tech. Phys.* **2,** 10, 2149–2155, June 1958. [Translated from *Zh. Tekh. Fiz., Akad. Nauk SSSR* **27,** 6, 2314–2320, Oct. 1957 by Amer. Inst. Phys., Inc., New York, N. Y.]

Diffusive creep may take place in solids for all possible stresses, excluding over-all compression and tension. If there exists a gradient in one of the principal normal stresses, there occurs a "directed self-diffusive" flow of atoms corresponding to creep, as in the case of a gradient in the over-all pressure.

The first viscosity coefficient, which describes creep under pure shear (or for an "incompressible" body), is of the same order of magnitude and is described by a formula of the same kind, in solid bodies, as the second viscosity coefficient which corresponds, in particular, to directed self-diffusion under the influence of a pressure gradient.

From author's summary by P. Whitton, England

60. Ogarkov, B. I., Theory of elastic fatigue (creep) in wood, *Soviet Phys.-Tech. Phys.* **2,** 5, 1016–1018, Feb. 1958. [Translated from *Zh. tekh. Fiz., Akad. Nauk SSSR* **27,** 5, 1118–1120, May 1957 by Amer. Inst. Phys., Inc., New York, N. Y.]

A brief method is presented for representing the combined effects of the elastic deformation of the cellulose component of wood with the elastic and plastic deformation of the lignin component under the action of a constant load applied for a long period of time. Straightforward summation of the time-dependent deformations results in an analytical expression which, it is claimed, is in exact agreement with experimental results of other (cited) references. P. E. Sandorff, USA

61. Sherby, O. D., and Dorn, J. E., Anelastic creep of polymethyl methacrylate, *J. Mech. Phys. Solids* **6,** 2, 145–162, 1958.

Specimens of a sample of commercial polymethylmethacrylate are tested in tension creep and it is found that all of the tension creep strain undergone at 92 C can be recovered if stress is removed and temperature is raised to 177 C. From this the authors conclude that creep deformation at the lower temperature is completely anelastic, meaning that there is no viscous flow or permanent plastic deformation. The same pattern of behavior was found to hold over the temperature range −10 C to +140 C and up to creep strains of at least 200%.

Authors also find that the measured activation energies for creep decreases with stress in the temperature range −10 C to +47 C and that above 47 C the activation energy increases rapidly with increasing temperature. These latter values were determined with sudden changes in temperature without the specimens having been unloaded and allowed to recover. Reviewer considers these last results to be misleading and not to be interpreted in the manner that they have been.

Y.-H. Pao, USA

62. Terry, N. B., Measurements of internal damping considerations of the rheological behavior of coal, *Fuel* **37,** 3, 309–322, July 1958.

Internal damping of coal specimens is measured from width of mechanical resonance curve. Paper describes manner in which vibration measurements on a composite rod (coal rod cemented to transducer rod) are used to determine internal damping in coal. An increase in damping with increasing stress amplitude was noted. Using Burger's model (spring and dashpot in parallel and the combination in series with a spring and a dashpot) a series of retardation times are deduced from vibration data. Calculated retardation times decrease with increasing frequency of vibration which indicates that a more complicated model is required. Author then examines behavior of a mechanical model composed of a series chain of parallel springs and dashpots and, in a rather interesting comparison, shows that this model is compatible with results of creep tests on coal. I. Finnie, USA

Plasticity,

(See also Revs. 50, 80, 84, 137, 158, 172, 241, 566)

63. Ellis, J. S., Plastic behaviour of compression members, *J. Mech. Phys. Solids* **6,** 4, 282–300, July 1958.

Paper describes a theoretical and experimental investigation of the plastic behavior of mild steel compression members of an annular cross section when subjected to end loads of equal and unequal end eccentricities. Theoretical collapse curves for a comprehensive range of such members are presented, and it is considered that the experiments support the analysis. From a comparison with the elastic theory it appears that the plastic theory will permit considerable economy in the design of columns of an annular cross section.

A method of analyzing columns in a framework is advanced. This method, which is iterative in character, is considered capable of handling combinations of elastic members, columns stressed in the plastic range, and beams containing plastic hinges.

From author's summary by G. Gerard, USA

64. Ellington, J. P., An investigation of plastic stress-strain relationships using grooved tensile specimens, *J. Mech. Phys. Solids* **6,** 4, 276–281, July 1958.

In 1953 Hill suggested that plastic stress-strain relationships could be obtained from strip specimens with deep oblique grooves. The author reviews the formulation of the test. Lode's parameters are obtained as function of the angle of inclination of the groove and of the angle of relative motion of the rigid sides of the groove, as the load is applied. In the present paper, author reports the results obtained from specimens of thoroughly annealed α-brass and copper. The curve (μ, ν) for brass lies very close to Mises' plastic potential $\mu = \nu$. For copper there is an appreciable deviation, probably due to anisotropy. A. J. Durelli, USA

65. Riabinin, Iu. N., Livshits, L. D., and Vereshchagan, L. F., The plasticity of brass at superhigh pressures, *Soviet Phys.-Tech. Phys.* **2,** 10, 2156–2159, June 1958. [Translation of *Zh.*

tekh. Fiz., Akad. Nauk SSSR **27,** 6, 2321–2325, Oct. 1957 by Amer. Inst. Phys., Inc., New York, N. Y.]

Using apparatus of the "Bridgman" type, authors report the results of tensile tests on brass carried out at pressures up to 30,000 kg/sq cm. Unlike steel in which the deformation at the neck increases linearly with pressure, brass shows a saturation value at about 10,000 kg/sq cm. The results from different brasses lead the authors to conclude that the plasticity saturation effect is characteristic of brass. F. Ellis, England

66. Marin, J., and Sharma, M. G., Design of a thin-walled cylindrical pressure vessel based upon the plastic range and considering anistropy, ASME-AWS Joint Metals Engng. Conf., St. Louis, Mo., Apr. 1958. Pap. 58-MET-2, 26 pp.

Paper develops a theory for finding the wall thickness of a thin-walled cylindrical pressure vessel in terms of the stress-strain relations in the plastic range and the maximum pressure that can be produced in the vessel. A paper by W. E. Cooper [AMR **10** (1957), Rev. 2519] covers a similar theory for isotropic materials. This paper extends the theory to nonisotropic materials. In addition, comparisons are made between available test results, both theories and current design code requirements.

From authors' summary by M. Botman, Canada

67. Hu, L. W., Modified Tresca's yield condition and associated flow rules for anisotropic materials and applications, *J. Franklin Inst.* **265,** 3, 187–204, Mar. 1958.

A stress-strain relation is proposed for perfectly plastic orthotropic material possessing different yield points in tension and compression. Application is made to the problem of a simply supported circular plate and to the plane stress enlargement of a circular hole. In each case the radial and circumferential directions are principal axes for the material and the stress.

Appropriate stress-strain relations for isotropic materials with different properties in tension and compression were discussed previously in connection with soil mechanics problems [Drucker and Prager, AMR **6** (1953), Rev. 299; Shield, AMR **9** (1956), Rev. 134]. The author has chosen a somewhat similar picture for plane stress with the entirely different option of lack of effect of hydrostatic pressure. At the same time there is no change in the yield surface as the deformation proceeds.

D. C. Drucker, USA

68. Storchi, E., One parameter solutions for the plastic region in plane stress (in Italian), *Atti. Accad. naz. Lincei, R. C. Sci. Fis. Mat. Nat.* (8) **22,** 5, 593–598, May 1957.

In the plastic region of a nonhardening material in plane stress, the author finds analytic solutions for the stress in the particular case of $\phi = \phi(p)$ where

$$\phi = \tfrac{1}{2} \arctan (\sigma_{yy} - \sigma_{xx}/2\sigma_{xy}) \quad \text{and} \quad p = \tfrac{1}{2}(\sigma_{xx} + \sigma_{yy}).$$

D. R. Bland, England

69. Madejski, J., Work-hardening, elastic aftereffect and residual stresses in the dynamical theory of plasticity (in Polish), *Rozpr. Inzyn.* **5,** 4, 457–478, 1957.

Structural changes in polycrystalline metals under the influence of external loads are discussed. For this purpose a two-phase model is considered resembling a honeycomb. The conglomerate (a) may be considered to represent dendritic crystals of the limit solid solution and the conglomerate (b) the intercrystalline joining material of higher elastic limit ($\sigma_{Eb} > \sigma_{Ea}$). The phase (a) may pass into phase (b) and vice versa, which is caused by heat addition. The considerations are based on the equation of state constituting a modification of the equation of the Maxwellian Model.

The problems discussed are: (1) the isothermal process of loading and unloading (the conditions of such a process being examined); (2) loading and sudden unloading of the model as a dynamic process; (3) the work-hardening process, consisting in subjecting the model to an oscillating load. The influence of the number of semicycles on the increase of grain fineness is discussed.

Z. Mroz, Poland

70. Johnson, W., Mellor, P. B., and Woo, D. M., Extrusion through single hole, staggered and unequal multi-hole dies, *J. Mech. Phys. Solids* **6,** 3, 203–222, May 1958.

Using slip-line field theory authors suggest solutions for four main types of extrusion problem. These are: end extrusion through perfectly smooth and rough wedge-shaped dies of unequal wedge angle; extrusion through three-hole dies with large reduction; side extrusion; combined end and side extrusion. The extrusion pressure with varying geometry is calculated and the limits over which the solutions obtained are valid is established. The problems are idealized but reviewer feels they will help to solve some puzzling problems in extrusion practice.

F. Ellis, England

Rods, Beams and Strings

(See also Revs. 43, 53, 55, 92, 93, 105)

71. Engel, E., Twisting of wire ropes and their torsional rigidity (in German), *Öst. Ingenieur Z.* **1,** 1, 33–39, Jan. 1958.

The twisting effect of a tension force on wire ropes is discussed. Relations are derived between the tension force and the induced twisting moment and between the moment and the angle of twist. The torsional rigidity of the wire rope is then given by the ratio between the moment and the angle, as usual.

Y. Y. Yu, USA

72. Postol'nik, Yu. S., The seminar on the dynamics of an inelastic strand of variable length (in Russian), *Prikl. Mekh.* **1,** 2, 241–243, 1955; *Ref. Zh. Mekh.* no. 9, 1956, Rev. 6212.

73. Megyeri, J., Exact calculation of loading on cable supports (in Hungarian), *Mélyépitéstudományi Szemle* **7,** 11/12, 375–381, Nov./Dec. 1957.

Distinction is made between actual cable tension and its horizontal component. Effects of wind loads and of friction at the supports are considered. Deviation from results of approximate analysis is found greatest when concentrated loads are applied midway between consecutive supports. Numerical tables are given, and also a nomogram for finding critical load combinations.

M. Hetenyi, USA

74. Solyanik-Krassa, K. V., The bending of round bars of variable cross section (in Russian), *Inzhener. Sbornik, Akad. Nauk SSSR* **22,** 206–218, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3386.

An investigation of the case of bending of round bars of variable cross section when the loads applied to the lateral surface of the bar are variable: p_r and p_z according to a law, $\cos\varphi$, and p_φ according to $\sin\varphi^r$. For this case, a system of the functions of the variables r and z is suggested as follows:

$$f = \frac{\partial f^*}{\partial z}, \quad \psi = \frac{\partial \psi^*}{\partial z}, \quad \psi = \chi + z\psi$$

$$F = \frac{\partial \psi}{\partial z} - 2\psi - f + r\frac{\partial f}{\partial r}, \quad \Omega = \frac{1}{r}\frac{\partial}{\partial r} - \frac{\partial f}{\partial z}$$

whereof the functions f^*, ψ^*, χ satisfy the equation

$$\nabla_3^2 \phi = \frac{\partial^2 \phi}{\partial r^2} - \frac{3}{r}\frac{\partial \phi}{\partial r} + \frac{\partial^2 \phi}{\partial z^2} = 0 \qquad [*]$$

The author examines the forms of the partial solutions of this equation in different systems of curvilinear coordinates in the r, z, plane, admitting of a division of the variables, in his monograph:

"Torsion of shafts of variable cross section" [Moscow, Gostekhizdat, 1949].

The stresses are expressed by linear combinations of the above-enumerated functions and their derivatives for r, z, containing the multiples cos φ for σ_r, σ_z, σ_φ, τ_{zr}, and sin φ for $r\varphi_z$, $r\varphi_r$. The functions must exactly satisfy certain boundary conditions on the lateral surface and the conditions of static equivalence on the ends. The latter conditions have the form for the solid bar:

$$\Omega(a) = \frac{1}{\pi} Q_x, \quad F(a) = -\frac{1}{\pi} M_y$$

for the hollow bar:

$$\Omega(a) - \Omega(a_0) = \frac{1}{\pi} Q_x, \quad F(a) - F(a_0) = -\frac{1}{\pi} M_y$$

wherein a, a_0 are the values of r for the inner and outer contours of the cross section respectively; Q_x, M_y are the shearing force and bending moment respectively. In orthogonal, isothermal coordinates, Eq. (*) assumes the form

$$\frac{\partial}{\partial \xi}\left(\frac{1}{r^2}\frac{\partial \phi}{\partial \xi}\right) + \frac{\partial}{\partial \eta}\left(\frac{1}{r^2}\frac{\partial \phi}{\partial \eta}\right) = 0$$

By this method, and applying spherical coordinates, solutions are obtained for the problem of the bending of a hollow, cylindrical and hollow tapering (conical) bar, respectively, under the action of a concentrated force, etc. The solutions of some of the problems, for instance of the bending of a pipe under hydrostatic load, are given for the first time. A solution is indicated for the problem of the stress concentration at a spherical cavity in a cylindrical bar, in plain bending and in bending by a concentrated force.

The solutions are illustrated by tables and graphs.

N. A. Rostovtsev

Courtesy of Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

75. Callahan, T. F., How to figure deflections of elastically supported cantilever beams, *Prod. Engng.* **29,** 31, 63–65, Aug. 1958.

76. Rachinskii, B. N., Torsion of a T-section beam of two different materials welded at the edge of contact (in Russian), *Trudi Tasbkentsk. in-ta. zh.-d. transp.* no. 5, 221–233, 1956; *Ref. Zh. Mekh.* no. 4, 1957, Rev. 4595.

Author divides the transverse section of a beam into rectangles, and represents the harmonic torsion function φ in the form of the series

$$\varphi_s = -xy + \sum_{n=1}^{\infty} \{A_n^{(s)} \sin b\, m_s x + B_n^{(s)} \cosh m_s x\} \sin m_s y$$

$$m_s = \frac{(2n-1)\pi}{2b_s}$$

having coefficients $A_n^{(s)}$ and $B_n^{(s)}$ different for each rectangle ($s = 1, 2, 3$). $2b_s$ is the width of the corresponding rectangle. At $s = 3$ the constant E is added to the expression for the function φ. The conditions of joining which are laid down for the function φ and its normal products in the boundary lead to an infinite system of equations for the coefficients $A_n^{(s)}$, $B_n^{(s)}$ and the constant E.

A formula is given for rigidity during torsion, and the curves for the equal tangential stresses τ_{zx} and τ_{yz} are drawn for one numerical example.

V. K. Prokopov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

77. Stantsov, B. T., and Demin, A. I., The deformation of curved rods (in Russian), *Sb. rab. stud. nauch. ov-a Pensensk. in-dustr. in-ta* no. 2, 12–39, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3571.

Plates, Shells and Membranes

(See also Revs. 66, 94, 95, 96, 114, 122, 126, 156, 178, 186, 206)

78. Medwadowski, S. J., and Pister, K. S., Strong cylindrical bending of elastic plates, *Proc. Amer. Soc. civ. Engrs.* **84,** EM 3 (*J. engng. Mech.*), Pap. 1692, 12 pp., July 1958.

Utilizing the refined theory of plate to include the effect of shear deformation (due principally to Reissner and Elinger), the problem of cylindrical bending of a simply supported isotropic infinite strip subjected to uniformly distributed normal pressure has been solved. The maximum stresses obtained by the refined and classical theories for span-depth ratio to 20 and 40 are tabulated under the normal pressure to 60 and 400 psi. It may be noted from the table that the difference in maximum stress from the classical and refined theories decreases as span-depth ratio increases, due to the increasing importance of axial stress and decreasing importance of bending stress.

T. Kanazawa, Japan

79. Zaid, M., and Forray, M., Bending of elastically supported rectangular plates, *Proc. Amer. Soc. civ. Engrs.* **84,** EM 3 (*J. engng. Mech.*), Pap. 1719, 26 pp., July 1958.

Authors solve the problem using the technique of superposition of the following elementary problems: (1) Rectangular plate simply supported on all four edges, subjected to the given temperature distribution or loading system; (2) rectangular plate subjected to an arbitrary line load on one edge and simply supported on the other three edges; (3) simply supported beam of variable rigidity, subjected to an arbitrary load distribution. As illustrations of the general solution technique, several of the possible combinations of support are discussed and, in addition, detailed solutions for deflection and bending moments are given for a square plate with one edge free.

T. Kanazawa, Japan

80. Schumann, W., On limit analysis of plates, *Quart. appl. Math.* **16,** 1, 61–71, Apr. 1958.

The bending of thin perfectly plastic (Tresca's criterion) plates of any arbitrary shape under transverse load is studied. The collapse load for a concentrated force on such a plate, either simply supported or clamped along its edge, is found to be 2π times the yield moment. The paper is a generalization of the work of Hopkins and Prager [AMR **7** (1954), Rev. 492].

M. L. Pei, USA

81. Kacner, A., A closed solution in the case of a semi-infinite plate with discontinuous boundary conditions (in English), *Arch. Mech. stos.* **10,** 1, 58–80, 1958.

Paper concerns the same problem solved previously by the author in another way [*Arch. Mech. stos.* **9,** 4, 371–380, 1957]. A semi-infinite plate strip is considered with the long sides simply supported, the transverse edge being free. Besides a normal load uniformly distributed over the plate, the plate is acted on by a distributed moment along part of the transverse edge, the moment vector being directed parallel to the edge. The deflection of this part of the edge should be proportional to the moment.

Expanding the unknown moment in a sine series, an infinite system of linear equations is obtained, the unknowns being the Fourier coefficients.

Author succeeded in determining the sums of the series appearing in the equations. He used the analogy between the form of integrals of certain ordinary linear differential equations and the series appearing in problem. The Fourier coefficients are expressed by elementary functions.

If the coefficient of proportionality between the deflection and the moment is equal to zero, concentrated moments calculated by the author will appear at the ends of the loaded segment.

Z. Kaczkowski, Poland

82. Tamate, O., Influence of an infinite series of equal circular holes upon the bending of thin plates (in German), *ZAMM* **37,** 11/12, 431–441, Nov./Dec. 1957.

Stress distribution and concentration along a hole in a plate have been investigated previously by various theoretical methods and experimental stress analysis, especially photoelasticity. In this paper Kirchhoff's theory of bending and the method of N.I. Muskhelishvili are used for approximate determination of the influence which infinite series of equal circular holes in the plate will have on the stress distribution if the plate is subjected to bending moments. Coefficients of the deflection function are determined by perturbation theory. Some special cases are discussed in numerical examples. J. J. Polívka, USA

83. Sawczuk, A., Limit load of ribbed plate structures (in Polish), *Arch. Inzyn. Ladowej* **3,** 3, 335–370, 1957.

Paper is concerned with the limit load of a rectangular plate with ribs along the periphery and supported on columns at the corners. The kinematical and the statical approach enable the determination of the upper and the lower load limit.

This method of determining the relations between the dimensions of the plate, the load, and the yield point avoids exaggerated values of the safety factor—higher than those assumed in the calculation. The determination of the internal forces in the limit state is strictly connected with the dimensioning of structural elements, assuming that the load-carrying capacity is exhausted (for instance, the so-called plastic deformation method in reinforced-concrete structures). Some numerical examples illustrate the method for calculating the internal forces.

D. Niepostyn, Poland

84. Olszak, W., and Murzewski, J., Elastic-plastic bending of nonhomogeneous orthotropic circular plates. Part I (in English), *Arch. Mech. stos.* **9,** 4, 467–485, 1957.

The problem under consideration is that of elastic-plastic bending of a circular plate cylindrically orthotropic and both elastically and plastically nonhomogeneous. The problem being axially symmetric, the known and the unknown quantities depend on the radius r only. It is assumed that the plate is thin, that is that the thickness is small in comparison to the outer radius and that the deflection is small in comparison to the thickness. The unit shear force $t(r)$ can, for a known load $p(r)$, be calculated directly from the equilibrium of the internal forces.

Two alternatives of the equations of the elastic-plastic state relating the bending moments to the curvatures are considered.

In the first alternative the incompressibility of the material in the plastic range and the existence of the plastic potential representing a quadratic form are assumed. Thus, the strain-rate field is obtained as well as the stress distribution, which shows, in general, a discontinuity at the boundary separating the elastic region from the plastic region. The resulting equations are involved and therefore less useful for practical purposes.

In the second alternative the stress distribution is assumed to be continuous in a cross section of the plate and uniform in the plastic zone. The equations of elastic-plastic bending prove to be simpler and enable the introduction of the yield condition in a more general form. This condition may be assumed in the form of either an ellipse or a polygon in the moment plane or in the curvature plane. The diagrams of limit states constitute, in the range of parameter values under consideration, a family of similar concentric geometric figures.

The limit conditions obtained may be considered to constitute models of the real conditions. Solution methods of the elastic-plastic problems connected with the given scheme and numerical examples will be published in the second part of the paper.

J. Naleszkiewicz, Poland

85. Alekseev, S. A., Postcritical work of flexible elastic plates (in Russian), *Prikl. Mat. Mekh.* **20,** 673–679, 1956.

The problem of the behavior of elastic plates loaded in their planes by forces applied at the boundaries, using von Karman's equations for large deflections of plates, is discussed in this paper. A general method of successive approximations to the solution of the problem is developed and an example of a rectangular simply supported plate loaded by uniformly distributed end loads acting on two opposite sides is solved in detail.

E. P. Popov, USA

Courtesy of Mathematical Reviews

86. Rubatch, O. M., The bending of circular plates reinforced by radial ribs (in Russian), *Sb. tr. in-ta stroit mekh. Akad. Nauk SSSR* 132–147, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3428.

The axially symmetrical bending of a circular plate reinforced on one side by closely spaced, radial ribs is examined. It is assumed that points on the median plane of the plate, contrary to the case of a plate without ribs, experience not only flexural displacements w_0, but also radial displacements u_0.

Assuming the deformations to be small, author sets up generalized equations for the axially symmetrical bending which ultimately resolve into a system of two second-order differential equations, linear with variable coefficients, in which the unknown functions are represented by the displacement u_0 and the derivative of the flexural displacement w_0. These equations are easily integrated in closed form; their integrals are represented by elementary functions. General expressions are indicated for the bending moments, shearing forces, and longitudinal stresses.

The particular case is examined in detail of a plate supported at the edge and bent by a concentrated force applied at the center, the solution being developed to numerical results and curves. The values obtained analytically are compared with experimental data, and a photograph is reproduced of the instrument used in these experiments, with a description of the experimental method. Comparison of the theoretical and experimental results shows satisfactory agreement. S. G. Lekhnitskii

Courtesy Referativnyi Zhurnal, USSR

Translation, courtesy Ministry of Supply, England

87. Popova, T. A., Some problems of the static work of a plate with a square aperture in its own plane (in Russian), "Researches on the strength, rigidity and stability of large-panel structures," Moscow, Gos. izd-vo lit. po str-vu i arkhitekture, 1954, 129–175; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3421.

The grid method is used to analyze the problem of the stresses and deformations in a square plate with a square aperture. It is assumed that this plate corresponds to an element of the side wall of a building, weakened by a window opening. It is further assumed that shearing forces are applied to the external contour, symmetrically to the diagonals and obliquely-symmetrical to the axes passing through the centers of the sides of the plate. In this case, owing to the condition of antisymmetry with reference to two of the axes, three arbitrary constants M_0, N_0, *and* Q_0, necessary for determining the stress function and its normal derivatives on the inner contour, will be equal to zero. This enables the solution of the problem to be restricted to a system of biharmonic equations with thirteen terms, without forming the equation of continuity of the deformations. A method is described for finding the components of the displacements by the method of finite differences. The case of a number of plates with apertures of equal size is examined, as well as the case of a plate without an opening; the author concluding that, with linear dimensions of the opening not exceeding 1/10th of the corresponding dimen-

sions of the plate, the presence of the opening does not affect the rigidity of the plate. With dimensions of the opening greater than 0.8 of the corresponding dimensions of the plate, the rigidity of the latter is equal to the rigidity of a frame of the same span. Some results are communicated of experimental investigations on such plates by photoelastic methods. P. M. Varvak

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

88. Baim, A. A., Stresses in a ponderable semi-plane weakened by an orifice (in Russian), *Dokladi L'vovsk. politekhn. in-ta* **1**, 2, 64-68, 1955; *Ref. Zh. Mekh.* no. 4, 1957, Rev. 4577.

Author determines distribution of stresses in an infinite plane field with an orifice, with stresses at infinity, respectively equal to the above-lying layers of earth and the values of the lateral thrust. The problem is solved by the methods of the two-dimensional problem of the theory of elasticity, using functions of a complex variable and conformal representation.

Graphs are given for the distribution of stresses along the contour of the orifice for two conditions on the contour: (a) the contour is free from external stresses, (b) for the case of an absolutely rigidly welded-in ring acting as a rigid strengthener.

A. B. Morgaevskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

89. Baim, A. A., Stresses in an infinitely compressed plate weakened by an arch hole, the edge of which is supported by an elastic ring (in Russian), *Dokladi. L'vovsk. politekh. in-ta* **1**, 2, 69-72, 1955; *Ref. Zh. Mekh.* no. 4, 1957, Rev. 4578.

Statement of the problem and method of solution are the same as for the previous paper [see preceding review]. The problem is solved in contour conditions corresponding to the case of an elastic ring made of another material welded into the hole.

Stress-distribution graphs are given of the hole contour.

A. B. Morgaevskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

90. Shakhramanov, G. S., The analysis of thin-walled, cylindrical shells by generalized formulas (in Russian), *Trudi nauch. korrespondentov in-ta stroit. dela Akad. Nauk GruzSSR* **1**, 65-81, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3413.

Calculation formulas are presented for the longitudinal, normal stresses and transverse bending moments in a prismatic assembly substituting a cylindrical shell with vertical side plating, analysed by means of octonomial, differential equations. The expressions obtained as a result of the solution of a system of algebraic equations, apart from coefficients depending on the geometrical dimensions, contain fundamental beam functions and coefficients of the expansion thereby of the external load, as well as six further constants, predetermined in relation to the central angle and the nature of the external load, for circular envelopes with central angles of 60°, 90° and 120°; tables of these values being given.

A. K. Morshchinskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

91. Csonka, P., On shells curved in two directions, Second Symposium on Concrete Shell Roof Construction, Oslo, July 1957; Session II, Pap. 5, 7 pp.

A shell with the middle surface $z = f(x,y)$ carries a smoothly distributed vertical load. The membrane forces can be derived from an Airy stress function satisfying a certain second-order differential equation. The author specifies $f(x,y)$ incompletely, leaving a free parameter A. He assumes the stress function to be a simple polynomial containing two more parameters B, C. Then A, B, C are found from the condition that the differential equation must be satisfied at three well-chosen points, and the result is slightly modified by requiring that the average of the load calculated from the differential equation must equal the average of the actual load. Several simple examples illustrate the method and show that in sufficiently simple cases acceptable solutions can be obtained. W. Flugge, USA

Buckling

92. Clark, J. W., and Knoll, A. H., Effect of deflection on lateral buckling strength, *Proc. Amer. Soc. civ. Engrs.* **84,** EM 2 (*J. engng. Mech.*), Pap. 1596, 19 pp., Apr. 1958.

This paper is one of a series on initially straight laterally unsupported beams and beam-columns that relates to lateral buckling theories that incorporate the effect of deflection. H. N. Hill and J. W. Clark (Proc. 1st U. S. Cong. Appl. Mech., p. 412) had previously obtained excellent correlation with test results when the moment term in Goodier's formula for lateral-torsional buckling of a beam-column was amplified to take approximate account of deflection. However, no account was taken of the opposed increase in lateral buckling strength of the bending component of beam-column behavior, also produced by deflection. The authors' beam-column tests were made with knife edge supports, thus providing lateral bending restraint at the ends. The authors show that while the strength-increasing effect of deflection is appreciable when the lateral end restraint is absent, this effect may be neglected in beams or beam-columns when lateral restraint is present. They conclude in their synopsis "that in the preparation of design rules for beams the effect of deflection need not be considered and that, in the case of beam-columns, the only effect of deflection that need be taken into account is the increase in bending moment caused by the deflection."

B. G. Johnston, USA

93. Giangreco, E., Theoretical-experimental research on lateral buckling of beams in the elastoplastic region (in Italian), *G. Gen. civ.* **96,** 1, 55-72, Jan. 1958.

Paper first gives approximate theoretical analysis, which can be considered as a simple modification of elastic analysis, of lateral buckling under pure bending, assuming elastic-perfectly plastic material. Basic assumption is that resistance against buckling is determined by part of cross section remaining elastic at critical load. Effects of variations of geometrical parameters are considered. Secondly, starting from same basic assumption, lateral buckling under three-point bending is analyzed by means of energy method. Results of this analysis have been verified by experiments, average experimental critical loads lying roughly 10% below calculated values. F. J. Plantema, Holland

Book—94. Korotkin, Ya. I., Loshkin, A. Z., and Sivers, N. L., Bending and stability of plates and circular cylindrical shells (Structural mechanics of ships) (in Russian), Leningrad, Gosud. Soyuz. Izdat. Sudost. Prom., 1955, 308 pp. 6.95 rubles.

This textbook is directed specifically toward beginning students in naval architecture and also machine design. The first two chapters present an exposition of linear small-deflection theory as applied to numerous problems involving various normal loads acting on thin elastic plates. The third chapter treats the elastic buckling of thin plates due to in-plane loads. Only the common loadings of either thrust or shear are presented. It is of interest to note that the concept of the ultimate strength of a rectangular plate, usually attributed to von Karman, Sechler, and Donnell, is presented here in a nearly-identical form but credited to Papkovich and Sokolov.

Chapter IV treats the bending of circular cylindrical shells subject to various simple external loadings. The bending of ring-stiffened cylindrical shells subject to hydrostatic pressure, a

problem of particular interest to the naval architect, is treated in detail, and tabular solutions due to Papkovich are presented. No comparison of these results with the more common theory due to von Sanden and Gunther is presented. Chapter V considers the buckling of cylindrical shells subject to hydrostatic pressure. The case of the ring-stiffened shell is again discussed in detail, but only on the basis of linearized theory. Lastly, the buckling of cylindrical panels subject to axial compression is considered.

The book is elementary in nature and lacks any exposition of nonlinear treatments of these problems. It does not appear to present any material not to be found in Timoshenko's "Theory of plates and shells." Further, the book is only scantily referenced and does not contain a single reference to the multitude of western literature in this field. W. A. Nash, USA

95. Norris, C. B., Compressive buckling curves for flat sandwich panels with isotropic facings and isotropic or orthotropic cores, *U. S. Dept. Agric., For. Prod. Lab. Rep.* 1854, 7 pp. + 15 figs., Jan. 1958.

Report presents curves and formulas for use in computing the buckling of flat panels of sandwich construction under edgewise compressive loads. Formulas for the buckling loads applying to panels with orthotropic facings and cores are used, obtained from a previous report. Curves provide values of critical loads in a rectangular panel, plotted against the ratio of the sides of the rectangle, for various values of a nondimensional parameter including geometrical and mechanical characteristics of the structure.

P. Santini, Italy

96. Grigoljuk, E. I., Buckling of sandwich constructions beyond the elastic limit, *J. Mech. Phys. Solids* **6,** 4, 253–266, July 1958.

General theory is developed for treating buckling of sandwich shells when the faces are stressed beyond the elastic limit. Equations for both flow and deformation theories of plasticity are given. Application is made to compression buckling of a rectangular plate. Formulas derived are undoubtedly valuable, but much tabulation of coefficients is required before application is possible. Experimental verification is also desirable.

W. S. Hemp, England

97. Anderson, M. S., Local instability of the elements of a truss-core sandwich plate, *NACA TN* 4292, 10 pp. + 8 figs., July 1958.

The charts presented give the compressive buckling coefficients for a single-truss-core and a double-truss-core sandwich plate. These charts cover a wide range of sandwich proportions and may be used for sandwiches with unequal faces. They apply to in-plane compressive loads acting parallel or perpendicular to the core direction or for various combinations of these loads.

From author's summary

98. Ting, L., and Yuan, S. W., On radial deflection of a cylinder of finite length with various end conditions, *J. Aero. Sci.* **25,** 4, 230–234, Apr. 1958.

Authors investigate radial deflections of cylindrical shell under a pair of equal and opposite concentrated radial loads for free, simply-supported and built-in ends. It is shown that Rayleigh's inextensional solution is sufficiently accurate for free ends if the length/radius ratio is comparatively small. Likewise Odqvist's solution for simply-supported ends is also adequate for comparatively short cylinders. Numerical data of present paper are helpful in determining range of validity of simplified equations and formulas. W. T. Koiter, Holland

99. Borot, H., Buckling of a thin-walled tube fitted in a rigid outer covering and subjected to an external pressure (in French), *Houille blanche* **12,** 6, 881–887, Dec. 1957.

The criterion of buckling for the title problem is found by author to be when the combined stress of direct pressure and flexure reaches the elastic limit of the material. The initiation of the buckling mechanism is ascribed to large plastic strain at one point of the ring, thus inducing instability. Experiments of steel rings with various thickness-radius ratios conform reasonably well to theory. Charts are presented for rapid determination of the buckling pressure. Results are extendable to long tubes.

D. H. Cheng, USA

100. Suer, H. S., Harris, L. A., Skene, W. T., and Benjamin, R. J., The bending stability of thin-walled unstiffened circular cylinders including the effects of internal pressure, *J. Aero. Sci.* **25,** 5, 281–287, May 1958.

Large deflection theories for buckling which include an initial imperfection parameter are unsatisfactory for design because an estimate of the probable initial imperfection must be made. Authors resort to semi-empirical treatment, arguing that statistical analysis of test data amounts to an evaluation of the effects of initial irregularities.

Previous tests reported in the literature were analyzed, and 58 additional tests performed on cylinders (10 unpressurized and 48 pressurized) fabricated from 0.0032 and 0.0087 gage 18-8 half-hard stainless steel. The cylinders were 17.5 inches in diameter and 21.5 inches long; authors nevertheless say, "Because test data in bending were not available for short cylinders, the present paper has been restricted to long cylinders unaffected by end fixity conditions." Tests were made with and without a compressive load balancing the axial pressure stress, and 90% probability curves are derived for the buckling coefficient as a function of r/t.

With some reservations about possible effects of varying length, radius, and end fixity, reviewer believes paper contains new and valuable information. A. D. Topping, USA

101. Rockey, K. C., Shear buckling of a web reinforced by vertical stiffeners and a central horizontal stiffener (in English), *Publ. int. Assn. Bridge struct. Engng.* **17,** 161–171, 1957.

Paper presents the results of an experimental investigation to examine the buckling due to shear of webs reinforced by vertical stiffeners and a central horizontal stiffener. New relationships have been obtained between the size and spacing of the vertical stiffeners, the size of the horizontal stiffener, and the buckling stress of the stiffened web. From author's summary

Vibrations of Solids

(See also Revs. 226, 227, 485, 581)

102. Kabulov, V. K., The integral equation of the longitudinal vibrations of bars (in Uzbeg), *Dokladi Akad. Nauk UzSSR* no. 3, 7–12, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3454.

The vibrations of an elastic, rectilinear bar of variable cross section are investigated on the basis of the Bernouilli hypothesis. The equation of motion is written in an integral form in the plane x, t, applying the theorem of change of quantity of motion. Integration along the characteristic $dx = \pm a(x)\,dt$ leads to a Volterra integral equation which is analyzed for the cases of an infinite and a semi-infinite bar. V. V. Bolotin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

103. Filipov, A. P., A review of results in the theory of the oscillations of rods (in Ukrainian), *Prikl. Mekh.* **2,** 2, 117–132, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3453.

This review contains the following sections: (1) General characterization of the fundamental researches; (2) Description of calculation methods; (3) Constrained vibrations, including the problem of the action of a moving load on a beam, and of oscilla-

tic· s under impact forces; (4) The influence of various factors on the oscillations of rods and bars: (a) Influence of the energy of rotation and the shearing force, (b) Influence of damping (by internal friction, from the supports, from the surrounding medium—air or water), (c) Influence of the action of the longitudinal force, (d) Influence of the nature of the constraint, (e) Torsio-flexural vibrations. A. I. Lur'e

Courtesy of Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

104. Bogusz, W., Influence of initial stresses on vibration of bars of constant cross section (in Polish), *Kozpr. Inzyn.* **6,** 1, 105–118, 1958.

This is a tentative theoretical determination of those parameters of longitudinal and transverse vibration of a bar, whose measurement will enable the calculation of the initial stresses.

The following assumptions are made:
(1) Every drag of the motion (the influence of the elastic hysteresis loop, in particular) is rejected.
(2) Confining the discussion to small vibrations of a parabolic dynamic characteristic (that is, the relation between the elastic force and the unit elongation) is assumed.
(3) The stress distribution is uniform over the cross section.

Obtaining a nonlinear partial differential equation of the second order by means of the perturbation method leads to the conclusion that, for the determination of two coefficients of the parabolic dynamic characteristic, the frequency, the amplitude, and the displacement of the vibration center should be measured.

A comparison of the dynamic and the static characteristic enable graphical determination of the initial stress.

M. Piatek, Poland

105. Wittmeyer, H., Natural torsional frequencies of a bar with variable cross section fixed at one end or submitted to boundary conditions slightly differing therefrom (in German), *Forsch. Geb. Ing.-Wes.* **24,** 2, 37–49, 1958.

Earlier work by the author [*Ing.-Arch.* **20,** 331–336, 1952] on the natural frequencies of torsional vibrations of rods of variable cross section built-in at one end and free at the other is simplified and improved. The method is extended to the calculation of the natural frequencies of vibration in torsion of rods of variable cross section elastically restrained at the ends.

E. Saibel, USA

106. Golovin, G. Ya., The vibration of bars in the presence of frictional forces (in Russian), *Nauch. zap. L'vovsk. politekhn. in-ta* no. 27, 109–116, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3477.

Approximate solutions are given for the differential equations of the longitudinal vibration of a bar under a frictional stress S corresponding to the relationship:

$$S = \lambda F \left(\frac{\partial^2 u}{\partial x \partial t} \right)^{\nu+1}$$

Suitable selection of the coefficient λ, according to the author, enables any mode of friction to be represented by this relationship. V. G. Timoshenko

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

107. Lazaryan, V. A., On the electrical simulation of transient conditions of the motion of a bar (in Russian), *Trudi Dnepropetrovsk. in-ta inzh. zh.-d. transp.* no. 25, 84–123, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3475.

The longitudinal and torsional vibrations of rods (bars) are analyzed by a method of electrical simulation, using an electrical linkage consisting of circuits with concentrated constants. Various methods of simulation are examined, both elastically-viscous systems and systems with a resistance proportional to the velocities in the cross sections. Experimental results are presented of the modelling of transient states of motion of bars on a model embodying 35 circuits. G. V. Savinov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

108. Nechayev, V. K., The "rigid" and "elastic" irregularity of rotation of a crankshaft (in Russian), *Izv. Tomskogo politekhn. in-ta* **75,** 253–264, 1954; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3473.

The constrained torsional vibrations of an engine shaft taking place under the action of a sinusoidal, external torsional moment are investigated; the "rigid" vibrations, corresponding to the motion of the system as a whole, are specially considered. Similar oscillations would take place if the shaft were absolutely rigid in torsion. The vibrations in question represent the so-called zero solution occurring in the normal case of analysis of the oscillation of free, i.e. unconstrained, systems.

F. M. Dimentberg

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

109. Pogorelov, A. I., The determination of the frequency of torsional vibration of a crankshaft (in Russian), *Nauch. tr. Kharkovsk. in-ta inzh. kommun. str-va* no. 6, 132–146, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3469.

110. Hirschhorn, J., and Johnston, K., A simplified tabular method for torsional vibration analysis of multiple-rotor shaft systems, *Mach. Design* **30,** 11, 141–146, May 1958.

111. Tchayevsky, M. I., An evaluation of the stability of motion of a flexible shaft with a disk mass (in Russian), *Nauch. zap. in-ta mashinoved. i avtomatiki Akad. Nauk USSR* no. 5, 67–85, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3471.

The motion is investigated of an ideal (imponderable) shaft with a disk mass, including the influence of internal friction in the material of the shaft.

The method of energy analysis is used to demonstrate that, when the shaft is rotating at hypercritical velocity, the internal friction causes instability of rotation, while the external friction, proportional to the velocity of motion of the center of the disk, promotes stability. It has been found, in this connection, that, in regard to stability of motion, the horizontal shaft is working in more favorable conditions than a vertical shaft.

V. L. Biderman

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

112. Chaevskii, M. I., Determination of the maximum of rotation torque in the shaft of a turbogenerator when suddenly short-circuited (in Russian), *Nauch. zap. in-ta mashinoved i avtomatiki Akad. Nauk USSR* **5,** 86–91, 1956; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 171.

A case is examined of the effect on the electric torque of a sudden short circuit on the shaft of a turbogenerator, when the turbine runs free and assuming that the action of the working fluid on the turbine wheel remains unchanged. It is shown that in these conditions it is essential to take into account not only the forced but also the natural damping of the oscillations of a 2-mass system. Formulas are given of the variations of the torque/time in three particular cases, on which basis, using graphs, it is proposed to determine the maximum torque on the shaft.

There are misprints in the article. M. K. Kristi

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

113. Kantham, C. L., Bending and vibration of elastically restrained circular plates, *J. Franklin Inst.* **265,** 6, 483–491, June 1958.

Paper deals with a general edge condition; the elastic restraint β is defined by $\alpha = \beta M$, where α is the slope at the edge, M the moment per unit length; the simply supported and clamped edges are the limiting cases $\beta = \alpha$ and $\beta = 0$. A circular plate with constant β is considered under uniform pressure; deflection at center and frequencies of transverse vibration are calculated.

O. Bottema, Holland

114. Yeh, G. C. K., and Martinek, J., Forced vibration of viscoelastic rectangular plate in fluid media (in English), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **5,** 340–351.

Simply supported plate in rigid infinite baffle is assumed to separate two different fluid media. Analysis takes into account interactions of the surrounding fluids and the internal material damping. Plate is set in motion by a normal incident simple plane wave developed in the first medium. Radiation of the plate reflects wave in the first medium. Motion of the plate is affected by the above and by the transmitted wave in the second medium. Authors assume that fluid media satisfies small amplitude wave equation; incident wave is of high frequency; Maxwell's stress-strain relations are valid for viscoelastic plate; plate deflection and thickness are small when related to other dimensions. Maxwell's and Torre's relations were used for triaxial equation which was solved by Galerkin's method. Authors defined transmission coefficient as ratio of mean rate of energy transmitted to the second fluid at interface two over mean rate of incident energy in the first medium arriving at interface one. In the limiting case of visco-rigid material the formulas for plate deflections and transmission coefficient appear to agree with Vogel's and authors' findings for purely elastic plate. Results appear to be applicable within region where fluid reaction pressure at any point on the plate is directly proportional to local velocity of fluid particles.

V. A. Valey, USA

115. DiMaggio, F. L., Dynamic elasto-plastic response of rigid frames, *Proc. Amer. Soc. civ. Engrs.* **84,** EM 3 (*J. engng. Mech.*), Pap. 1693, 30 pp., July 1958.

The forced elasto-plastic vibrations of a two-hinged or fixed rigid frame, acted upon by a time-dependent concentrated force at the knee, are investigated. In particular, numerical calculations are carried out for a two-hinged frame subjected to a linearly decaying force.

The moment-curvature diagram for the frame members is assumed to be elastic up to some moment M_0, at which a plastic hinge is formed and the moment remains constant so long as the rate of plastic work is positive. The solution is given in terms of elasto-plastic normal modes, in accordance with a method proposed by Bleich and Salvadori ["Impulsive motion of elasto-plastic beams," *ASCE Trans.* **120,** p. 499], for the first elastic stage. Author finds that in the second elastic stage it is apparently impossible to determine the moment at the knee since the various expressions given do not converge. The effect of the concentrated force on plastic bending and of longitudinal vibrations of the members is not considered.

P. Seide, USA

116. Housner, G. W., and Outinen, H., The effect of torsional oscillations on earthquake stresses, *Bull. seism. Soc. Amer.* **48,** 3, 221–229, July 1958.

Maximum stresses induced by earthquake-excited vibrations of unsymmetrical and symmetrical structures are compared.

The usual static method underestimates the maximum stresses, and a correction should be made if it is used in connection with a design which has to keep the maximum stress within a given limit. The greater the eccentricity between the center of mass and the center of rigidity, the greater the deviation between the dynamic and the static analysis.

B. Gutenberg, USA

117. Timoshenko, V. V., The frequency of free oscillation of flat, parabolic arches of variable cross section (in Russian), *Trudi Dnepropetr. in-ta, inzh. zh.-d. transp.* no. 25, 301–317, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3449.

The frequencies of free oscillation of flat, symmetrical, unhinged, parabolic arches are given for a law of change of moments of inertia of the cross sections:

$$I_x = \frac{I_1}{[1-(1-n)(2x/l)]\cos\varphi} \qquad \left(n = \frac{I_1}{I_2\cos\varphi}\right)$$

where I_1, I_2 are moments of inertia in the crown and in the feet, x distance of the cross section from the crown, l span of the arch, φ angle of inclination to the horizon of the tangent at the cross section.

In forming the differential equation of the oscillations, the displacements are determined without regard to the influence of curvature and transverse forces; the longitudinal forces are considered only in calculating the thrust. The inertia forces are only considered in the vertical direction. The solution of the equation of oscillation is obtained by the Bubnov-Galerkin method.

For the function Φ satisfying the boundary conditions of the set problem, the known fundamental functions of the oscillations of parabolic arches have been introduced: $I_x = I_1 \sec\varphi$. The results of the calculations are embodied in tables of the coefficients of the first and second frequencies (harmonics) for values of n between 1 and 0.2, and values of f/i_1 (where f is rise of the arch, i_1 radius of gyration of the cross section in the crown) between 0 and 0.20. The errors of the calculation are investigated. Approximation formulas obtained from the data of constructed arch bridges are given for the first and second circular frequencies ν_1 and ν_2.

A. A. Pikovskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

118. Ziemba, S., Free vibration of systems of one degree of freedom with nonlinear elastic characteristic and nonlinear viscous-type damping (in English), *Arch. Mech. stos.* **10,** 2, 163–193, 1958.

Author analyzes the homogeneous differential equation of motion of a material point with one degree of freedom with nonlinear characteristics of viscous damping depending on the velocity of the point and elastic properties depending on the displacement. In particular, he discusses the number of zeros of the solution of the equation of motion with arbitrary boundary conditions in the following four cases: (a) "soft" elastic and "hard" damping characteristic; (b) "hard elastic and "soft" damping characteristics; (c) "hard" elastic and "hard" damping characteristic; and (d) "soft" elastic and "soft" damping characteristic.

The considerations are based on the method of comparison of the solution of a nonlinear equation with the corresponding linear equation or by replacing the differential equation by an integro-differential equation. The results are summed up in the end section of the paper. According to the author's opinion, the results obtained may be used for the design of shock absorbers for single impulses.

K. Piszczek, Poland

119. Skowronski, J., Linear damping of a single impulse by a nonlinear shock-absorbing system (in Polish), *Rozpr. Inzyn.* **6,** 1, 121–141, 1958.

A motor car with its springs and pneumatic tires represents a complicated vibrating system. A computation of such a system is difficult in view of a considerable number of degrees of freedom and the requirements concerning the accuracy of calculation. The author has chosen the most important part of the problem of motor car vibration, limiting the considerations to a system of one degree of freedom with one wheel, a linear damping element and a nonlinear elastic element. The paper is intended to furnish practical directions for designers. It contains an analysis of the requirements and a description of several computation methods:

(1) the method of expansion in series; (2) Picard's approximation method; and (3) Lienard's graphical method.

Unfortunately, author did not furnish a more practical example of application of these methods to encourage the designers by providing a comparison between the methods and facilitating the choice of one. K. Wolski, Poland

120. Lewandowski, A., An investigation of the alternating character of free nonlinear vibrations by means of comparison (in English), *Arch. Mech. stos.* **10**, 1, 81–97, 1958.

First, the nonlinear differential equation of motion, describing the free vibration of a material point with one degree of freedom, is interpreted as an equation of a surface in a rectilinear system of coordinates (deviation, velocity, acceleration). Next, in the neighborhood of the singular point, author replaces the nonlinear equation with a linear one, which means, from the geometric point of view, a replacement of a surface by a tangent plane. From the geometrical interpretation, conclusions are drawn conceming the character of the singularity.

In the next part of the paper author uses the method of comparison of phase trajectories of the nonlinear and the linear equation in the case of critical damping. Thus four theorems are obtained from which conditions follow to be satisfied by the nonlinear term of the equation and the way of choosing the initial conditions in order that the motion of the material point be not alternating. K. Piszczek, Poland

121. Badke, A. O., Man's new environment—vehicle vibration, *Mech. Engng., N. Y.* **80**, 7, 38–41, July 1958.

Wave Motion and Impact in Solids

(See also Revs. 57, 204, 562, 563, 564, 565)

122. Piszczek, K., The possibility of dynamic stability loss under moving concentrated loads (in English), *Arch. Mech. stos.* **10**, 2, 195–210, 1958.

Paper is concerned with the problem of dynamics of a plate subjected to moving loads. Author derives the general equations of the problem for a plate resting on an elastic Winklerian foundation with arbitrary boundary conditions. Next, he determines, for a rectangular simply supported plate, the critical (resonance) velocities of translation of a concentrated load. If moving mass is taken into consideration the problem reduces to the determination of the instability regions of an equation of the Mathieu-Hill type. The results are generalized to the case of a system of forces.

M. Bieniek, Poland

123. Ivanilov, Yu. P., Some plane problems of impact on a vessel containing liquid (in Russian), *Trudi Azerb. industr. in-ta* no. 12, 22–30, 1956; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 433.

Three problems are investigated on the impact effect on a container filled with an ideal incompressible liquid, with a free surface: (1) horizontal impact of the container taking the shape of a round segment; (2) vertical impact of a round cylinder, half immersed in liquid, filling the container of the same shape, when the cylinders are eccentrically disposed; (3) horizontal impact of the container taking the shape of a round sector. In the first case the space occupied by the liquid is reflected in regular fashion on the band with the consequent discovery of the potential for the speed of the disturbed movement of the liquid in the light of Fourier's integral. In the second case the space occupied by liquid is reflected on a rectangle and the speed potential assumes the form of a Fourier series. In the last case the space occupied by liquid is reflected on a half-band and the potential emerges as the sum of the Fourier series and integral. In all the cases expressions are given for the addition of mass.

E. L. Blox
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

124. Miller, R. W., Comparison of hydrodynamic-impact acceleration and response for systems with single and with multiple elastic modes, *NACA TN* 4194, 12 pp. + 2 tables + 11 figs., Feb. 1958.

Paper presents hydrodynamic impact tests made with a multimode elastic model consisting of a rigid prismatic float and a flexible wing. Reference is made to a previous paper [*NACA TR* 1074] where the problem was treated analytically on a system of two rigid masses connected by a massless spring; results were substantiated by *NACA TR* 1075 where the two-mass system was approximated by a rigid float and a light-weight flexible wing supporting a concentrated mass at each tip. The purpose of the tests reported in this paper was to determine the integrated influence of higher modes and the validity of the two-mass system for the case of actual continuous mass-distribution. Comparison of experimental data obtained in hydrodynamic impacts with theoretical and experimental results for a single mode system having the same mass ratio led to the following conclusions:
(1) The theoretical c. g. accelerations as computed in *NACA TR* 1074 are generally in agreement with the experimental results;
(2) The higher modes present in the elastic system have no significant effect on the c. g. accelerations;
(3) Curves of the theoretical oscillatory accelerations of the hull approximate the shape of the curves of the experimental results but overestimate their magnitude, probably because of damping in the system. P. Santini, Italy

Soil Mechanics: Fundamental

(See also Rev. 132)

125. Ungar, J., Some aspects of sediment and soil classification (in Hungarian), *Hidrológiai Közlöny* **37**, 1, 34–43, Jan.–Mar. 1957.

126. Fischer, K., Calculation of settling of a rigid lightly loaded plate strip on layered ground (in German), *Beton u. Stahlbeton.* **52**, 10, 254–256, Oct. 1957.

With stresses in a semi-infinite elastic body, stresses and strains in the body due to contact pressure under a rigid infinitely long plate on the surface are calculated. Settlement is obtained by integration of strain along the vertical line beneath the middle of the plate. In case of layered body, stresses are assumed not to be influenced by such constitution. Tables are provided to facilitate computation.

T. Mogami, Japan

127. Haberzak, A., Some experiments concerning the geostatic pressure (in Polish), *Rozpr. Inzyn.* **6**, 1, 145–165, 1958.

Author begins with justifying the necessity for experimental investigation of the geostatic pressure for the determination of the real values of soil pressure against walls, the problem being not yet solved in a decisive manner.

The principal part of the paper contains a detailed description of the apparatus designed by the author and the results of experiments carried out by him using that apparatus. A special device for determining the values of the vertical component of the geostatic pressure against a vertical wall deserves special mention. Both the value of the horizontal and the vertical component of the resultant pressure against the wall of the apparatus are determine by measuring the values of friction by extracting from the soil special vinidur or steel bars. The experiments were carried out by using dry sand. The distribution of sand pressure against a

wall was examined as well as the influence of sand compression on the pressure. It was found that with compressed sand the value of the horizontal component of the pressure increases considerably, the value of the vertical component remaining unchanged.

The end of the paper is devoted to comparison of the values of the geostatic pressure obtained by the author with those calculated on the basis of Coulomb's assumptions and with the results of investigations by Terzaghi and Skibinski.

J. Czulak, Poland

128. Lobanov, T. Z., Horizontal stresses in settlements (in Russian), *Gidrotekh. Stroit.* **25,** 8, 51–54, Aug. 1956.

129. Turiev, K. V., and Kodochigov, P. N., Determination of soil density by gamma-rays (in Russian), *Gidrotekh. Stroit.* **25,** 6, 36–42, June 1956.

Soil Mechanics: Applied

(See also Revs. 18, 196)

Book—130. Proceedings of the Fourth International Conference on Soil Mechanics and Foundation Engineering, Vol. I, xiii + 466 pp., Vol. II, xi + 467 pp., Vol. III, ix + 291 pp., London, Butterworths, 1958, $79.50 per 3-volume set.

The Proceedings of the Conference are presented in three volumes. Volume I contains the papers presented in Divisions 1, 2, and 3A. Volume II of the Conference Proceedings contains the papers from Divisions 3b, 4, 5, 6, and General Reports. Volume III contains the discussions of the papers from all Divisions as well as a name index to all three volumes.

Division 1a. Soil properties and their measurement; Fundamental and natural properties: Bolognesi and Moretto (1a/3) describe silty soils derived from loess, and show that index properties cannot predict mechanical properties (see also Kassiff, 1a/14). Florentin et al (1a/7) consider laterite formation, low density and physical and mechanical properties. Gibbs and Holtz (1a/9) describe laboratory research on penetration tests and sand density, while Janik et al (1a/12) and Skopek (1a/26) have used neutron methods to measure porosity in sands and gravels. Heidema's paper (1a/11) on bar-linear shrinkage test for measuring PI deserves attention, in reviewer's opinion, for soils of medium to zero PI. Meigh and Early (1a/16) studied properties and sampling of intact and shattered chalk, and Skempton and Henkel (1a/25) give valuable information about properties of London clay at depth (for important discussion by Ward see Vol. III, p. 122). Soderblom (1a/27) measured salt contents *in-situ* on organic Swedish clays to estimate sensitivity.

Division 1b. Soil properties and their measurement: Mechanical properties: Aitchison (1b/1) defines unsaturated, quasi-saturated and partially saturated soils, and relates strength of first two groups to pressure deficiency in pore water. Hilf and Gibbs (1b/6) have tested compacted soils at constant σ_3', as basis for designing 500-ft earth dams. Kirkpatrick's paper (1b/9) on stress conditions at failure in sand is outstanding; he concludes that Mohr-Coulomb strength theory is best and can reliably predict failure in fully drained tests of sand. Rowe (1b/12) suggests that $c_e = 0$ in normally-loaded clays at equilibrium, and that "creep" is mainly caused by shear stress applied to "true cohesion" part of shear strength. The main part of this paper seems likely to remain controversial for a long time.

Division 2. Techniques of field measurement and sampling

The regrettably small number of papers (9) is offset by quality of content, and five of these deal with *in-situ* measurement of sand density (related to papers 1a/9, 1a/12, 1a/26). Cambefort (2/1) used electrical resistivity and alternating current; Durante et al. (2/2) used freezing, penetration resistance, and γ-ray absorption; Palmer and Stuart (2/5) the standard dynamic penetration test, while Plantema (2/6) measured the static resistance to a cone; great interest was aroused during the discussion on Schultze and Knausenberger's paper (2/9) on static and dynamic penetrometers of many types. Dvorak (2/3) describes field tests on rocks at dam sites, and Serota and Jennings's paper (2/8) on undisturbed sampling techniques for sands and very soft clays seems to be the only one dealing wholly with this important subject.

Division 3a. Foundations of structures: General subjects and foundations other than piled foundations: The only common theme running through a large group of papers is that of settlement. Egorov et al. (3a/7) give observed and calculated settlements of multi-story buildings in Moscow. Gibson and McNamee (3a/8) calculate consolidation settlement under corner of rectangular loads on soil surface; Grasshoff (3a/9) studies interaction of structure and foundation as it affects bending moments and contact pressures. L'Herminier et al (3a/10) used vibrating-wire gages to measure soil reactions under the first French atomic reactor, where 1/4-1/2mm/meter differential settlement was allowed. Polshin and Tokar (3a/31) present Russian methods and standards for allowable differential settlements. Simons (3a/38) has analyzed two structures on normally-consolidated clay which developed large settlements. Williams's description (3a/43) of the foundation design for the Shell building in London includes the measures taken to avoid differential settlements; the excavations would cause large upward movements of underlying tube railway tunnels.

Other papers include Baracos and Bozozuk's useful paper (3a/2) on seasonal shrinking and swelling in Canadian clays; Bjerrum and Overland (3a/6) describe the tilting failure of an oil tank due to lens of softer clay under one side. Ishii et al. (3a/11) study factors, such as side "friction" in consolidation test, affecting design of sand drains; Kérisel (3a/15) considers influence of successive arching on increase of N_q with depth. An unusual case of swelling is described by Mayer and Habib (3a/23), where spilled phosphoric acid turned calcium carbonate in a chalky soil into insoluble tricalcium phosphate at a lower density. Meyerhof (3a/26) extends his earlier bearing-capacity theory to foundations on or near slopes, and Roscoe's work (3a/35) on tied and free pier foundations is an important factor in plastic behavior and design of structures. Finally, Steuerman and Murphy (3a/39) describe the foundation of the Hampton Roads tunnel, which includes some unusual cut-and-fill procedures.

Division 3b. Foundations of structures: Piling and piled foundations.

Buckling of piles in soft clay is studied by Brandtzaeg and Harboe (3b/4), Golder and Skipp (3b/7) and Bergfelt (3b/2) who also includes axial and lateral pile bearing capacity. Friction pile foundations are dealt with by Bjerrum et al (3b/3), who measured settlements of a bridge on compressible silty clay with marked secondary compression, and by Zeevaert (3b/17), who used a partial foundation of this type in unconsolidated and very compressible Mexican clay. Two unusual causes of failure of bored piles are described by Hobbs (3b/8); Sørensen and Hansen (3b/13) have compared various piling formulas and failure loads, while Tomlinson's paper (3b/14) on the adhesion of piles in clays is valuable. Van der Veen and Boersma (3b/15) and van Weele (3b/16) include an interesting pile-loading method.

Division 4. Roads, runways and rail tracks

Black and Croney (4/2) describe soil suction studies under roads and Grimer and Ross (4/4) show importance of small aggregation size in soil cement. Hatherly and Wood (4/5) describe seasonal soil temperature and moisture content variations in Iraq; Ivanov et al. (4/6) present Russian views on flexible pavement design; King and Pitt (4/8) have measured the fatigue strength of clays, showing softening dangers in over-consolidated clay formations.

Soil stabilization research at M. I. T. is surveyed by Lambe (4/10), and Lewis (4/11) has studied factors influencing impact soil compaction, giving theory for impact pressures. McLeod (4/12) and Moraldi (4/14) report and analyze plate bearing tests on airport pavements. Three papers concerned with the CBR test are those by Nascimento and Simoes (4/15), who relate the results to modulus of strength, by Turnbull and Ahlvin (4/18) who rationalize the thickness design formula, and by van der Veen (4/20), who emphasizes the difficulty of deciding between soaked and unsoaked values.

Division 5. Earth pressures on structures and tunnels

Earth pressure studies have been made by DiBiagio and Bjerrum (5/2) in a trench in stiff clay, using vibrating-wire load cells, by Lane (5/7) on stiff and flexible tunnel linings using Whittemore strain gages, and by Ward and Chaplin (5/13) using vibrating-wire strain gages. Last two papers show effects of neighboring tunnels and disadvantages of stiff lining. Janbu (5/4) has extended his method of slices to earth pressure and bearing-capacity calculations, and Kujundzic (5/5) has studied rock anisotropy related to bedding planes. Sowers et al. (5/11) have measured lateral pressures caused by compaction, and Tschebotarioff and Ward (5/12) determined bending moments in sheet pile walls by accurate slope measurements.

Division 6. Earth dams, slopes and open excavations

Pore pressure measurements in dams are given by Bar-Shany et al. (6/3) for a fat clay dam, by Nonveiller (6/18) on two dams, and by Schiltknecht and Bickel (6/23) on a rolled fill dam. Bishop (6/8) discusses the growth and dissipation of pore pressures in dams and their estimation for design purposes, while Bernell and Nilsson (6/7) used an R-C electrical analogy net to calculate expected pore pressures in two dams.

The long-term stability of slopes in stiff-fissured London clay is studied by Henkel (6/12) and Skempton and DeLory (6/24), two papers which deserve careful study. Bernell (6/6) has studied the properties of moraine deposits, and Zweck and Davidenkoff (6/30) have conducted valuable experiments on vertical and horizontal filters. Hurtubise et al. (6/14) describe landslips in Eastern Canada; Meardi (6/16) used sand piles in consolidation of soft clays; arching effects in embankments are considered by Trollope (6/25). Peterson et al. (6/19) describe several dam failures, which also receive mention in Rao's paper (6/21) on Indian dams, with causes and remedial measures taken.

Reviewer's comments:

Many papers in all Divisions failed to give a complete and precise description of the soils concerned, particularly if they were cohensionless. Often the methods used in obtaining the quoted strengths were obscure or insufficiently described. The plethora of different c's and ϕ's makes one heartily wish for an international convention of limitation to a few essential symbols with clearly defined meanings and implications. Too many papers give few or no references to work outside their own continent or to earlier work. However, such criticisms must be tempered by realization of the unavoidably severe limitation on the length of papers.

There are surprising gaps in the aspects covered, where few or no papers have been published in these Proceedings. Sampling of clay, fundamental studies on dilatancy and pore pressure as they affect soils of different grain size, index properties of sands [maximum, minimum, and relative porosities]—these are just the first three that come to mind, despite the large and rapidly increasing number of workers in the field.

Without doubt the contributions of Professor Terzaghi to the various sessions should be read for their practical wisdom and the fascinating glimpses they give of his unique philosophy (pages 55, 98, 135, 154, 199, 246, 263). Some of the other contributors (to Vol. III) provided major items of new material, but choice of them would be invidious. It is far from easy to find with any certainty where contributors have mentioned any particular paper, and regular users are advised to make their own list of discussion references to avoid missing an important item which occurs outside the Discussion Session in which it should theoretically have been given.

The high production standard of the Proceedings reflects great credit jointly on the Committees concerned and the publishers. Like the Proceedings of earlier Conferences of the International Society, they will remain indispensible for reference for many years to come. Careful selection of the 179 papers has insured a high average quality. T. K. Chaplin, England

131. Harms, F., and Berz, R., The support pilings used in construction of subways according to the building method used in Berlin (in German), *Bautechnik* **34**, 3, 89–94, Mar. 1958.

Book—132. Huntington, W. C., Earth pressures and retaining walls, New York, John Wiley and Sons, 1957, xv + 534 pp. $11.50.

The book with its 34 chapters discusses everything that a structural engineer should know about earth pressure and the design of retaining walls. Fifteen chapters deal with earth pressure, four with the foundation of retaining walls, and seven with static computations. Soil properties are treated in detail, and individual procedures for the computation of the earth pressure and especially the problems of stability against shear failure, overturning and slope failures are minutely analyzed and provided with graphs which facilitate a rapid computation. Computations of the earth pressure are based upon a modern analysis with due regard to the deformations of the earth mass. Even methods of designing reinforced-concrete members of the walls are dealt with and the cantilever wall-design receives considerable attention.

Reviewer thinks that only two items could be criticized: first, the occurrence of pressure at rest should be also introduced (e.g., during dynamic loads, during swelling processes in the soils, etc.) and a respective design procedure should be presented. Second, the grouping of several methods for determining each pressure is not arranged lucidly and also the methods which are later characterized as unsuitable are analyzed. This applies to the majority of methods for determining the passive resistance on soils as well as the earth pressure in cohesive soils, if the plane surface of sliding is made use of. Rebhann's construction (accurately, Poncelet's construction) as well as Cullman's construction are only the application of the Coulomb solution and should not be individually introduced.

In spite of these critical comments engineers have been provided with a book which is of considerable help in understanding the questions of earth pressure and in designing retaining walls.
V. Mencl, Czechoslovakia

133. Thompson, W. E., Measurements and power spectra of runway roughness at airports in countries of the North Atlantic Treaty Organization, *NACA TN* **4303,** 5 pp. + 56 figs., July 1958.

Processing of Metals and Other Materials

(See also Rev. 70)

134. Tomlinson, A., and Stringer, J. D., Closing of internal cavities in forgings by upsetting, *J. Iron Steel Inst. Lond.* **188,** 3, 209–217, Mar. 1958.

Upsetting as a means of closing internal cavities in forgings has been investigated using small-scale models containing artificial cavities. The effect of upsetting on cavities has hitherto been uncertain, but the results of the present work suggest that all cavities could be closed by upsetting by following authors' method.

Upsetting tools with dished working faces have been developed which would enable upset pieces to be produced not only free from

cavities, but also of a suitable shape for reforging. The tests suggest that the reforged pieces would have satisfactory mechanical properties at the positions of healed cavities.

From authors' summary

135. Konoreko, V. G., The problem of press-shaping sheet metal parts (in Russian), *Trudi Khark. aviats. in-ta* no. 15, 183–200, 1954; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3504.

136. Averkiev, Yu. A., Analysis of the peripheral compression of hollow cylindrical blanks of a die with a curvilinear end product (in Russian), Machines and treatment of metals by pressure, Moscow, Mashgiz, 1955, 73–91; *Ref. Zh. Mekh.* no. 4, 1957, Rev. 4749.

137. Colwell, L. V., Controlling tool life, *Tool Engr.* **41,** 1, 65–69, July 1958.

138. McFeron, D. E., and Chao, B. T., Transient interface temperatures in plain peripheral milling, *Trans. ASME* **80,** 2, 321–329, Feb. 1958.

This is the first step published on the problem of heat flow and temperatures that obtain under the intermittent cutting conditions typical of milling. A fairly elaborate analysis is required, despite the usual simplifying assumptions. The results for temperature check the analysis quite well. A somewhat unexpected result was to indicate that, in milling, a smaller fraction of cutting energy goes into the chips and a greater one into the tool, compared with a lathe cut. E. G. Loewen, USA

139. Chao, B. T., and Trigger, K. J., Temperature distribution at tool-chip and tool-work interface in metal cutting, *Trans. ASME* **80,** 2, 311–320, Feb. 1958.

Paper represents an interesting extension of the authors' earlier work in calculation of cutting-tool temperatures, especially in that it shows how considerable detail in temperature distribution can be obtained without resorting to iterative procedures. It also indicates how temperatures can be found along the clearance as well as the cutting face of the tool. Direct experimental evidence is not available, but authors discuss all indirect data which can be tied in. E. G. Loewen, USA

140. Merchant, M. E., Production research in metal cutting, ASME Ann. Meet., New York, N. Y., Dec. 1957. Pap. 57-A-99, 5 pp.

141. Letner, H. R., Influence of grinding fluids upon residual stresses in hardened steel, *Trans. ASME* **79,** 1, 149–153, Jan. 1957.

142. Halverstadt, R. D., Analysis of residual stress in ground surfaces of high-temperature alloys, *Trans. ASME* **80,** 5, 1104–1107, July 1958.

Fracture (Including Fatigue)

(See also Revs. 49, 59, 173, 174, 175, 181, 184)

143. Hunt, J. B., Fracture mechanism of semi-brittle steels in torsion, *J. Mech. Phys. Solids* **6,** 4, 321–326, July 1958.

In torsion tests, mild steels usually classified as ductile did not fail in either pure shear or tension. This was observed in static and dynamic tests at different temperatures. With increasing twist a local plastic zone first appeared, and plastic strain increased until microcracks formed at the surface. Separation at that time did not take place as the core offered too high a resistance, but the stress distribution was affected. At fracture, primary tensile failure appeared at the core and surface, followed by separation by shear in between.

F. DeKazinczy, USA

144. Shahinian, P., and Achter, M. R., Effect of environment on creep-rupture properties of metals, *Nav. Res. Lab. Rep.* 18–24, Apr. 1958.

The utilization of metals at high temperatures in various types of gas and liquid atmospheres requires the development of adequate data and theory covering the effects of environment. Creep-rupture properties of various nickel and nickel-base alloys have been investigated. It has been found that the metals are stronger in air than in vacuum at high temperatures and low stresses but that the reverse is true at low temperatures and high stresses, in that they are stronger in vacuum. Factors which modify this atmosphere effect are oxidation resistance and ductility of the material. A mechanism to explain this reversal is proposed which involves two competing processes: oxidation strengthening and reduction in strength by decrease in surface energy.

From authors' summary

145. Hartbower, C. E., Crack initiation and propagation in the V-notch Charpy impact specimen, *Welding J.* **36,** 11, 494s–502s, Nov. 1957.

It has been suggested that brittle fracture may be distinguished from ductile fracture by the manner in which the initiating crack is propagated; a brittle-fracture crack is propagated by continuous release of the elastic-stress field surrounding the crack, whereas a ductile-fracture crack requires plastic deformation work to extend the crack. Because the energy value obtained from conventional V-notch Charpy impact tests integrates the crack-initiation and crack-propagation stages of the fracture process, it was deemed necessary to investigate a modification of the conventional impact testing technique to permit differentiation between the crack initiation and propagation stages.

Two approaches were investigated. Both involved the initiation of a crack by means of an initial low-energy blow of the impact-machine pendulum. The first method determined the highest temperature at which the initial low blow caused complete fracture of the test specimen, i.e., the temperature at which the low-blow-initiated crack propagated by continuous release of the elastic-stress field developed by the initial blow. The second method required the measurement of lateral expansion after the crack-initiating low blow and again after a second, fracturing blow. The use of lateral expansion as a measure of the plastic-deformation work was based on the previously established proportionality between lateral expansion and energy absorbed (work done) in fracturing the test bar. When the fracturing blow did not produce a significant increase in lateral expansion, the plastic-deformation work done in extending the initiating crack was essentially zero and the fracture was considered to be brittle. The highest temperature permitting crack propagation without plastic-deformation work to extend the crack was taken to be the brittle-fracture transition temperature.

Multiple low blows delivered at or below the brittle-fracture transition temperature provided a possible explanation for brittle fractures in service which have occurred under conditions of static load and/or low nominal stress. For example, specimens from highly notch-tough material, subjected to an initial low blow of 20 ft-lb, fractured under a single additional 10 ft-lb capacity low blow with no measurable plastic deformation attending the second (crack-propagating) blow when tested below the transition temperature. Thus, an analogy is suggested between performance as observed in the laboratory test specimen and the case of a bridge, ship, or storage tank which is subjected to local plastic yielding (and possibly crack initiation) at points of stress concentration in

one load cycle, and then fractures in a brittle fashion in a subsequent load cycle involving low nominal stress.

From author's summary

146. Medovar, B. I., The mechanism of formation of intercrystalline cracks in the heat-affected zone in fusion welding, *Soviet Phys.-Tech. Phys.* **2,** 7, 1454–1457, June 1958 [Translation of *Zh. tekh. Fiz., Akad. Nauk SSSR* **27,** 7, 1571–1574, July 1957 by Amer. Inst. Phys., Inc., New York, N. Y.]

Tests with copper, sulfur, boron, and zirconium indicate cases where cracks in heat-affected zone are a continuation of intercrystalline cracks formed during solidification of molten pool. Base metal directly adjacent to weld is subjected to tensile strain and atoms are able to move along grain boundaries and promote cracks. Adequate amounts of low-melting eutectic liquid with surface-active elements fill these cracks. Otherwise cracks are not filled. Conclusion is that molten weld metal composition is related to cracks in heat-affected zone.

C. R. Freberg, USA

147. Regel, V. R., Elongation curves of TlBr + TlI monocrystals (in Russian), *Trudi in-ta kristallogr., Akad. Nauk SSSR* no. 11, 152–157, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3735.

A systematic evaluation is made of the elongation curves of ionic crystals of TlBr + TlI at 8 different temperature values in the range from $-185°$ to $+250°$, and for two rates of relative deformation, of 1.7×10^{-2} and 1.7×10^{-4} sec^{-1}, respectively.

With increasing temperature, the limiting value of the deformation at which rupture of the sample takes place increases, while the yield limit falls; at low temperature, the samples rupture at deformations of only a few percent, while at 100° temperature and above, the elongation before rupture attains 120%. The shape of the elongation curves varies with the temperature; at low temperatures the stress in the sample after the yield point is passed increases regularly up to fracture; at high temperatures, the stress attains a certain maximum, after which it begins to decrease perceptibly. The reason for the occurrence of this stress peak is now known. A relationship has been established between the yield limit and the limiting temperature stress and the rate of deformation. This relationship materially changes with increasing temperature.

M. P. Shaskol' skaya

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

148. Zhitnikov, R. A., and Stepanov, A. V., An optical method for investigating the mean stress condition in finely-granulated polycrystals. III Photoelastic (piezooptical) properties of polycrystalline silver chloride (in Russian), *Zh. tekh. Fiz.* **26,** 4, 786–794, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3766.

An experimental investigation of the photoelastic properties of polycrystalline samples of AgCl with varying structural treatment. The values of the pitch differences have been measured in relation to the stress values in tension for different values of the angle ϕ between the direction of tension and the direction of rolling (for a rolling texture), or the direction of pressing (for the texture of a pressed sample).

The photoelastic law of linear relationship between the pitch difference and the tensile stress is adequately fulfilled for all stresses at which a polycrystalline, textured plate exhibits averaging of the optical effects.

The measurement of the piezo-optical constants C for different values of the angle ϕ and angle α (between the elastic and the optical isoolines) is described. Polar diagrams of C for press-formed and rolled strips are compared with similar diagrams calculated for a monocrystalline plate the surface of which coincides with a surface of a cube. Complete coincidence of these diagrams leads to the conclusion that the rolling contours (pressing contours) of polycrystalline AgCl are identical with those of metals with a space-centered, cubical lattice. For finely-granular, quasi-isotropic, not work-hardened, recrystallised samples, the degree of scattering of the values of C is very great, and the photoelastic law is not fulfilled; apparently this is associated with the very low elastic limit of AgCl. A slight degree of work-hardening of such plates abruptly changes their photoelastic properties; the relationship of the pitch difference to the stress likewise becomes linear, and the value of $C = +15.3 \times 10^{-7} cm^2/kg$ is sufficiently accurately determined. The data obtained on the piezo-optical properties of AgCl enable photoelastic methods to be applied to the quantitative investigation of two-dimensional stress conditions in polycrystalline sample.

M. P. Shaskol' skaya

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

149. Frost, N. E., The fatigue strength of specimens cut from preloaded blanks, *Metallurgia, Manchr.* **57,** 344, 279–282, June 1958.

Tests on specimens cut from the body, i.e. away from the surface, of material preloaded in various ways show that prior fatigue testing has no effect on the fatigue strength of aluminum alloy L.65. Static preloading in compression or torsion increases the fatigue strength of mild steel and decreases it for the L.65 aluminum alloy.

From author's summary

150. Felgar, R. P., Effect of shot-peening on fatigue strength, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-46, 9 pp.

Shot-peening introduces three effects: (a) cold-working, (b) residual stress, and (c) concentrations. The relation of these effects to fatigue strength is discussed on the basis of data available in the literature. It is shown that the influence of the induced residual stress on the fatigue strength can be predicted on the basis of a concept due to Rosenthal and Sines. Prediction of the strength of manufactured parts and laboratory specimens, based on this concept, agree closely with observed values.

From author's summary

151. Ryabchenkov, A. V., and Kazimirovskaya, E. L., Influence of heat treatment on the fatigue strength of steel subject to atmospheric corrosion (in Russian), *Vestn. mashinostroeniya* no. 1, 69–72, 1955; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 2510.

Results are stated of investigations of heat-treated steel 45, suffering from fatigue due to corrosion. It is stated that the strength of a surface heat-tempered steel suffering from corrosion fatigue is considerably better than an improved steel in the same conditions. When open to the influence of humid air, with 0.27% SO_2 content, the fatigue strength of a normalized steel falls by 17.5%; the improved, by 47%; and the surface heat-tempered by 16%.

M. M. Saverin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

152. Shashin, Ya., and Kononov, Yu. I., The shape of the fatigue curve (in Russian), "Design and construction of machinery parts," Moscow, Mashgiz, 1956, 3–11; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3740.

Results of fatigue tests are presented, made to determine the value of the exponent m in the equation of the fatigue curve $\sigma^m N = \text{const}$ in relationship to the kind of steel, stress-concentration, and surface strain-hardening by shot-blasting. The original results are evaluated by a statistical analysis of a small number of results. From the experimental data it follows that, for smoothly-ground impact samples in combined torsional bending, the mean probable value of the exponent m is determined by the expression $m = 17\sigma_{-1}/\sigma_b$. Workhardening by shot-blasting raises

the value of the exponent m (for instance, in one case, from 7 to 1"), and reduces the stress concentration, while at the same time the less the radius of curvature of the notch, the lower the value of the exponent m.

V. P. Kogaev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

153. Hochberg, M. M., The work of metal structures under variable stress (in Russian), "Design of machines and equipment," Moscow-Sverdlovsk, Mashgiz, 1956, 81–99; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3909.

Results are presented of tension-compression tests on flange and butt-joint seams. Data are given on the type of failure and also strain curves of samples made of a low-alloy steel (type NL) and Steel 3, as well as the values of the effective coefficients of (stress) concentration. Considerations are presented on the calculation of metallic structures with allowance for fatigue.

I. I. Trapezin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

154. Phelps, E. H., Stress corrosion in metals, *Prod. Engng.* **29,** 31, 56–58, Aug. 1958.

Stress plus chemical environment can make it difficult for some alloys to resist cracking. Here are the characteristics of this delayed-action damage, and some design steps to head it off.

From author's summary

Experimental Stress Analysis

(See also Revs. 148, 204)

155. Prigorovsky, N. I., and Khessin, G. L., Stress analysis of the structure of a high-pressure hydroelectric power station of submerged type (in Russian), *Trudi Mosk. inzh.-stroit. in-ta* no. 16, 123–140, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3669.

The advantages are examined of the method of modeling using a material with a low modulus of electricity, compared with the photoelasticity method. Indications are given on the most suitable material (an organic glass), on the arrangement of the strain measurements (electric strain gages, varnishes), and on the conditions of similarity. Details are given of the organization and results of model tests on dams.

I. K. Snitko

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

156. Jessop, H. T., Snell, C., and Holister, G. S., Photoelastic investigation on plates with single interference-fit pins with load applied (a) to pin only and (b) to pin and plate simultaneously, *Aero. Quart.* **9,** 2, 147–163, May 1958.

The reduction in stress-concentration factors resulting from the introduction of an interference-fit pin in a circular hole in a flat plate to which a simple tension is applied has already been recorded. The same result is found to occur to an equally marked extent, and qualitatively in a very similar way, when the load is applied to the pin itself. When varying loads are applied to the pin or the plate, the effect of the interference is to produce a rise in the mean stress level at critical points on the hole boundary with a marked fall in the oscillatory stress. There appears to be an optimum value for the "interference stress" for given applied loading conditions at which the endurance of the plate will have its highest value.

When loads are applied simultaneously to pin and plate the critical stress on the hole boundary is found to be the mean of the stresses which would be produced by the total load applied separately to the pin and to the plate.

From authors' summary

157. Van Zee, A. F., and Noritake, H. M., Measurement of stress-optical coefficient and rate of stress release in commercial soda-lime glasses, *J. Amer. ceram. Soc.* **41,** 5, 164–175, May 1958.

A method is described for measuring the stress-birefringence properties of soda-lime glasses in the range 23 to 650 C. Data on three glasses show that the stress-optical coefficient increases slowly with temperature, reaching a definite maximum in the range 570 to 590 C. The same apparatus was used to measure the rate of stress release in two of these glasses. Data obtained under thermal equilibrium conditions can be represented by equations that suggest two or more concurrent mechanisms are involved in stress release in these glasses within the viscosity range log 12 to log 14.5 (a rapid one of 0.4 to 10 minutes duration and a slow one of 2 to 60 minutes).

From authors' summary

158. Kawata, K., Analysis of elasto-plastic behavior of metals by means of photoelastic coating method, *J. sci. Res. Inst. Tokyo* **52,** nos. 1471–1477, 17–40, Mar. 1958.

Photoelastic material bonded to a metal surface provides a means of measuring the elasto-plastic strain distribution along the surface of the metal. A new photoelastic material, epoxy-polysulfide copolymer, is studied for use at room temperature. This polymer had suitable properties: large maximum elongation, low Young's modulus, high strain-optical sensitivity, and high bonding strength to metal. Strain-optical law of the photoelastic coating and method of deriving stress and strain in metals from observations of isochromatics, etc., are discussed. Practical examples of elasto-plastic stress concentration are solved by the method. The author, however, neglects mentioning or correcting for the drop off in strain picked up by the coating at free edges of the model, and the residual edge effects due to machining or to temperature changes.

T. J. Dolan, USA

159. Grishkova, N. P., An optical method for stress measurement in machinery parts (in Russian), Kiev-Moscow, Mashgiz, 52 pp., 1953; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3807.

160. Anonymous, Strain gage applications (pictorial demonstration), *Instrum. and Automat.* **31,** 3, p. 446, March 1958.

161. Krause, N. A., Strain gage calibrations and flight loads testing techniques, *AGARD Rep.* 113, 19 pp. + 28 figs., Apr./May 1957.

The measurement of structural loads in flight is no longer restricted primarily to fundamental flight research, but is rapidly becoming a standard test program on aircraft models destined for production. Military specifications have been developed stipulating requirements for the demonstration of structural integrity through flight loads measurements. Since a flight loads program represents a considerable expenditure of man hours, sound planning, scheduling and selection of instrumentation are stressed. Two basic instrumentation systems for measuring flight loads are being used—the pressure distribution system and the strain-gage system—each having certain advantages and disadvantages.

This paper deals with experiences with strain-gage systems during a number of comprehensive loads programs. Methods of installation and calibration of strain-gage systems are discussed. Flight maneuvers and methods of execution to obtain the desired data are outlined and typical test data shown. Techniques used in the handling and analysis of the data are discussed with examples of typical final results showing the concept of testing to 80% limit load and extrapolation to 100% limit load to determine critical load conditions and their magnitude. The use of automatic electronic equipment and other development programs which are improving the efficiency of conducting loads programs are discussed.

From author's summary

162. Kammer, E. W., and Vigness, I., Lattice defects and strain-gage factors, *Proc. Soc. exp. Stress Anal.* **15,** 1, 179–184, 1957.

The resistivity changes of wires subjected to elastic strains are caused by a perturbation of factors responsible for the initial resistivity and not due to an introduction of independent sources of resistance. The different factors causing resistance each have independent resistance-strain coefficients which combine to form a composite coefficient. The component coefficients are independent of temperature. Wires of high resistivity have resistance-strain coefficients that are nearly independent of cold-work and temperature because their resistivities are predominantly caused by but one factor. From authors' summary

163. Nossov, S. S., Determination of stresses in engine parts by means of wire strain gages (in Russian), Symposium on the design of prime movers no. 33, 1955, 32–47; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3686.

The requirements to be applied to the current take-off arrangements for measuring strains are listed, as applied in the Central Scientific Research Institute on Diesel Engines: (a) with brushes pressed against collector rings by cylindrical springs; (b) with brushes in elastic frames; (c) by mercury contacts. The first two systems of current collecting have worked satisfactorily at 4000–10,000 rpm; the last-named method is efficient between 0 and 25,000 rpm. N. I. Prigorovskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

164. Korsakevich, N. I., The adaptation of electronic strain gages of the ID-2 type for investigating the dynamic stress conditions in machinery parts (in Russian), *Nauch. tr. in-ta mashinoved. i s.-kh. mekhan. Akad. Nauk. USSR* **5,** 40–50, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3798.

The ID-2 instrument is the one most commonly used for determining static deformation by means of resistance wire strain gages.

Various measures are suggested for adapting this instrument to the measurement of dynamic deformations.

The circuit of the instrument, working on a carrier frequency of 850 cps, is supplemented by an inverted-U filter at the demodulator output, passing without distortion currents of frequencies down to 85–100 cps. The filter consists of two condensers of 50 mF each and a choke with an inductance of about 0.0035 Hy. An additional circuit is also provided for balancing the bridge to the reactive component of the bridge arms (phase corrector). Methods are examined of suppressing parasite currents arising in the vibrator (loop) of the oscillograph, and determined by the following causes: (1) Non-identity of the volt-ampere characteristics of the valves of the ring modulator; (2) incomplete balancing of the measuring bridge according to the reactive components of the bridge arms; and (3) presence of higher harmonics in the voltage of the carrier frequency feeding the bridge.

It is recommended to match the valves (selenium disks of 18-mm diameter) most carefully, by identical volt-ampere characteristics, with subsequent balancing of the demodulator by the inclusion of rheochords in its circuit. Balancing should be performed with the regulating voltage cut off.

The inner arms of the bridge should have bifilar windings. All iron binder screws should be replaced by brass.

A calibration curve and a frequency characteristic of a particular instrument are given, showing that the mechanical process being investigated is transmitted without distortion down to a frequency of 70 cps, and that for loads up to 500 kg/cm² the calibration curve is practically linear. The sensitivity of the instrument working with a 5th type vibrator in the MPO-2$_4$ oscillograph and 100-ohm resistance transmitters is about 15 kg/cm² per 1-mm record. The adaptation of the instrument can be performed without disturbing the structural layout.

The ID-2 instrument is fed from a storage battery; changes in the battery voltage cause errors of the order of 1.2–1.5% per 1% change of stress. Hence it is necessary to work on the horizontal section of the storage battery discharge curve. The battery tension is controlled by a voltmeter. It is also recommenced to feed the instrument from an external source of a-c voltage with a suitable characteristic. In the investigation of dynamic events the galvanometer of the ID-2 instrument is intended to be cut out.

A. M. Turichen

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

165. Popov, I. A., An instrument for dynamic measurements with wire gauges (in Russian), "The measurement of stresses and strains in machinery parts," Moscow, Mashgiz, 1955, 76–88; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3799.

166. Pustynnikov, V. G., An auxiliary device for determining principal dynamic stresses by the ellipsometer method (in Russian), *Izv. Akad. Nauk SSSR, Otd tekh. Nauk* no. 5, 124–130, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3806.

A description is given of an auxiliary arrangement for an ellipsometer which enables the latter instrument to be used for determining dynamic deformations. The device works on the principle of measuring, by a needle indicator, the mean deformation values in machinery parts at any instant of time. The deformation of the part is measured by means of a bridge circuit incorporating resistance-wire strain gages (200–250 ohms) connected in the plate circuit of a thermionic valve which by means of a peak-transformer circuit is opened at time instants corresponding to a particular position of the mechanism. The impulses opening the valve circuit are obtained from a special phase regulator. A calibration circuit for the instrument is shown.

The arrangement for solving the equations of the ellipse of the dynamic deformation consists of connecting the input circuit of the ellipsometer, instead of the bridge circuit, in the plate circuit (of the valve).

The device enables measurement of dynamic deformations with a frequency of 3–4 c/s and over. V. N. Maksimov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Material Test Techniques

(See also Revs. 177, 518)

167. Widdowson, A. E., A simple tensile testing machine for very fine wires, *J. sci. Instrum.* **35,** 3, 100–101, Mar. 1958.

A simple machine is described by which stress-strain curves can be obtained for fine tungsten wires as small as 5 μ in diameter. From author's summary

168. Gurevich, Ya. B., The nature of the yield limit in tension (in Russian), *Fiz. metallov i metallovedeniye* **2,** 1, 137–141, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3716.

Tests were made on ingots weighing 0.7–1.0 kg, of a medium-carbon steel (0.45% C), melted in an open, high-frequency furnace under a slag blanket, and in a vacuum (down to 10^{-2} mm Hg) without slag. From these ingots, rods of 8-mm diameter were prepared, followed by annealing at 780°. The tensile tests were made on a micro-testing machine, on test pieces of 1.0-mm diameter with a test length of 5.5 mm. 19 ingots were tested from the open-melted batch, and 5 from the vacuum-melted batch. The grain size was controlled, and was in all cases identical: 300–500 μ^2. Depending on the conditions of melting, the samples dif-

fered in the quantity of nonmetallic inclusions (about 0.01% weight in open melts and 0.001% weight in vacuum melts) and quantity of occluded gases (especially oxygen and nitrogen). In the vacuum-melted samples, the area of the yield point on the stress-strain diagram was over 2½ times greater than in the case of the open melts; the percentage elongation also increased, and the elasticity and yield limits were somewhat lower. The author explains the difference in the elongation curve and the mechanical properties of these samples by the difference in the gas content and nonmetallic inclusions; he is of the opinion that the process of plastic deformation is influenced in the initial stages not only by the character of the grain boundaries, but also by the conditions of the ferritic grain itself. P. O. Pashkov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

169. Gordobey, A. T., Bulygin, I. P., and Mikheyev, N. I., A machine for testing high-temperature strength under programmatically-variable conditions (in Russian), *Zavod. Lab.* **22**, 4, 468–490, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3756,

170. Ivanov, A. I., Machines and apparatus for testing timber developed by the CNIIMOD-AI (in Russian), "The physical and mechanical properties of wood," Moscow, Leningrad, Goslesbumizdat, 1953, 67–74; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3796.

A universal machine for testing wood (timber) in compression, tension, static bending, glue strength, cleavage, hardness determination, proportionality, and elastic modulus is described.

A press is described, for testing wood in compression along the grain, a pendulum hammer for impact bending testing, instruments for testing the impact hardness of timber, and determining the percentage of winter growth. A. F. Rozhnyatovskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

171. Burnett, H. C., A recording torsion testing machine for wire, *ASTM Bull.* no. 227, 68–69, Jan. 1958.

The recording system utilizes a spark and a heat-sensitive paper and is entirely frictionless, so that even small torque values may be accurately recorded. From author's summary

172. Ratner, S. I., An evaluation of the strength of metals in conditions of complex stress under static load (in Russian), "Increased machinery life," Moscow, Mashgiz, 1956, 5–20; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3714.

Author investigates some of the most effective methods of improving the strength of machinery parts made of high-duty materials. These include: isothermal working; formation of a plastic layer around stress raisers by localized, high-frequency annealing; finishing methods adapted to improving the quality of the surface layer (sand-blasting).

Results are presented of tensile and torsional tests in high-pressure atmospheres. The influence of the dimensions of the part on strength is examined. Indications are given of the influence of machining conditions in the preparation of the sample on the test result. K. K. Likharev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

173. Garf, M. E., A new machine for programmed fatigue tests (in Russian), *Zavod. Lab.* **21**, 10, 1238–1241, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3751.

A machine is described for fatigue-testing materials, using rotating notched-bar test pieces of a diameter up to 5 mm. The machine can automatically change the value of the test load during the progress of the test, and control the number of load cycles in each loading stage, within wide limits. The tests are made at only two stress levels. Provision is made for using more complicated, multistage program of test-load variation.

N. M. Rudnitskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

174. Mikhailiv, P. A., A machine for the fatigue-testing of metals in pulsating tension or compression (in Russian), Nauch. zap. in-ta mashinoved. i avtomatiki, Akad. Nauk USSR, **3**: "Problems of mechanical engineering and strength in machine design," no. 2, 100–110, 1954; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3750.

175. Fisher, W. A. P., Experimental correlation between the endurance of a wing spar joint and the ratio between 0.1 per cent proof and ultimate tensile strengths of the material, *Aero. Res. Counc. Lond. curr. Pap.* 371, 7 pp. + 2 tables + 8 figs., 1958.

Axial fatigue tests were made on a series of specimens representing the Viking outer wing spar joint. Significant correlation was found between low Proof/U.T.S. ratios of the material and high endurance of the joint.

Tests on Dove boom research specimens indicate that this correlation is not peculiar to the Viking joint and the results are in agreement with theoretical and experimental work published by K. Gunn. From author's summary

176. Setty, S. K., Lapsley, J. T., and Thomsen, E. G., Stresses alter hardness, ASME Ann. Meet., New York, N. Y., Dec. 1957. Pap. 57-A-77, 3 pp.

Authors test metal specimens for hardness while subjecting them to uniform and gradient stresses. Results bear out theory that materials become softer under tension, harder under compression. From authors' summary

Properties of Engineering Materials

(See also Revs. 23, 60, 64, 65, 142, 144, 151, 168, 187, 233, 236, 321, 378, 431)

177. Vosteen, L. F., Effect of temperature on dynamic modulus of elasticity of some structural alloys, *NACA TN* 4348, 9 pp. + 2 tables + 3 figs., Aug. 1958.

The effect of temperature on Young's modulus of elasticity was determined from flexural beam vibration tests for 2024-T3 and 7075-T6 aluminum alloys, AZ31A-0 magnesium alloy, RS-120 titanium alloy, and type 303 stainless steel at temperatures from room temperature to 900 F. The test frequencies were varied from 40 to 550 cps. The results are compared with values of moduli obtained from conventional stress-strain tests. The data show that the dynamic modulus decreases with temperature but does not decrease as rapidly as the static modulus. It is shown that the difference between the static modulus and dynamic modulus is due to internal friction and cannot be attributed to creep.

From author's summary

178. Stein, B. A., Compressive strength and creep of 17-7 PH stainless-steel plates at elevated temperatures, *NACA TN* 4296, 9 pp. + 3 tables + 13 figs., July 1958.

Compressive strength test results from room temperature to 1000 F and compressive creep test results from 700 F to 1000 F are presented for plates of 17-7 PH stainless steel, Condition TH 1,050, which were edge-supported in V-groove fixtures. Plate width-thickness ratios range from 15 to 60. Master curves are presented which show the combinations of average stress, temperature, and time which produce given amounts of creep strain or failure of the plates and which facilitate interpolation of the test results. The test results are compared with plate strengths and

creep failure stresses determined from semiempirical approximations. From author's summary

179. Decker, R. F., Rowe, J. P., Bigelow, W. C., and Freeman, J. W., Influence of heat treatment on microstructure and high-temperature properties of a nickel-base precipitation-hardening alloy, *NACA TN* 4329, 24 pp. + 4 tables + 18 figs., July 1958.

Studies were made of the influence of various heat treatments on rupture properties and microstructure of a 55Ni-20Cr-15Co-4Mo-3Ti-3Al alloy to provide more fundamental information on the relationships between structure and high-temperature properties in alloys of this type. The effects of variations in solution treatment, cooling rate after solution treatment, and aging treatment on the stress-rupture properties of the alloy at 1600 F and 25,000 psi were measured and related to variations in the size and distribution of precipitates within the alloy and to residual rolling effects. From authors' summary

180. Voce, E., The strain-hardening behaviour of high purity copper—An appraisal of tests by Carreker and Hibbard, *Metallurgia, Manchr.* **57,** 341, 111–116, Mar. 1958.

A critical analysis of previously published true stress-strain data by means of an exponential strain-hardening function provides a basis for understanding the effects of temperature and grain size on mechanical behavior of pure copper.

G. V. Smith, USA

181. Anevi, G., An empirical method of determining the crippling stress for flanged frames of Alclad 24 S-T at room temperature and elevated temperature, *SAAB Aircr. Co., Linköping TN* 40, 9 pp. + 6 tables + 7 figs., 1958.

The investigation covered by this report was intended to provide design data for flanged frames of Alclad 24 S-T at elevated temperatures. Forty separate tests were carried out on a normal type of frame with the dimensions in which SAAB is currently interested. The results show that the design rules which apply at room temperature can also be used at elevated temperatures with the addition of a factor that takes account of the properties of the material as they affect the crippling stress. It was also found that a certain amount of creep has only a quite moderate adverse effect on the crippling stress.

Tentative design data are presented, according to which the allowable crippling stress can be found by means of a fairly simple formula or nomogram. From author's summary

182. Gerard, G., New era dawns for flight materials and structures, *Astronautics* **3,** 8, 20–21, Aug. 1958.

The age of hypervelocity flight, inaugurated with certain missiles and proposed boost-glide rocket vehicles such as Dyna-Soar, brings with it a greater emphasis than ever before on material design technology. From author's summary

183. Stansbury, J. G., Stretched acrylic—a transparent glazing material for high-speed aircraft, *Aero. Engng. Rev.* **17,** 1, 42–46, Jan. 1958.

Improved shatter and craze resistance at reduced weight and simplification of edge attachment design are made possible by stretched acrylic glazing. From author's summary

184. Saito, H., and Tanaka, K., Fracture and static charge of high polymer with a comment for heat notch, Proc. Sixth Japan Nat. Congr. appl. Mech., Univ. of Kyoto, Japan, Oct. 1956, 205–208.

185. Wood, L. A., Stress-strain relation of pure-gum rubber vulcanizates in compression and tension, *J. Res. nat. Bur. Stands.* **60,** 3, 193–199, Mar. 1958.

The stress-strain curve in tension for a typical pure-gum rubber vulcanizate after a given period of creep, according to Martin, Roth, and Stiehler, can be represented by an empirical equation

$$F = M(L^{-1} - L^{-2}) \exp A(L - L^{-1})$$

where F is the stress based on the original cross-sectional area, and L is the ratio of stressed to unstressed length, M is the slope of the stress-strain curve at $L = 1$ and A normally has a value close to 0.38. The present paper shows by an examination of data published by Sheppard and Clapson, Treloar, and Rivlin and Saunders that the equation is also valid in the region of compression for values of L as small as 0.5 (50% compression). The features of the empirical equation are discussed and comparisons are made with the equation predicted by the statistical theory of rubber elasticity and the equation derived by assuming Hooke's law for the stressed cross section. The consequences of the validity of the empirical equation in terms of the Mooney-Rivlin presentation of the strain energy function are pointed out. The equation predicted by the statistical theory represents observed data very well in the compression region from $L = 0.5$ to $L = 1.0$. The Mooney equation is approximately valid from $L = 1.5$ to $L = 3.5$. Neither of these equations is satisfactory in the important intermediate region from $L = 1.0$ to $L = 1.5$. The empirical equation represents the observed data over all three of these regions. It is concluded that Young's modulus M can best be obtained from the intercept of a plot of $\log F/(L^{-1} - L^{-2})$ against $(L - L^{-1})$. For $0.75 < L < 2.00$ it is thoroughly satisfactory to determine M as the intercept of a plot of $F/(L^{-1} - L^{-2})$ against $(L - 1)$.

From author's summary

Structures: Simple

(See also Revs. 63, 95, 97, 115, 132)

186. Goldberg, J. E., and Leve, H. L., Theory of prismatic folded plate structures (in English), *Publ. int. Assn. Bridge struct. Engng.* **17,** 59–86, 1957.

The subject structure is defined as one composed of rectangular plate components connected along parallel edges and closed at the end by an end diaphragm or bulkhead. The purpose of the paper is to determine the stress distribution, and the moments and forces arising at the joints, due to enforcing continuity at these junctions. Because of the two-dimensional aspect of the structure as opposed to a one-dimensional truss structure, influence functions are generated instead of influence coefficients.

The influence functions are found by expanding the displacements and rotations of the edge of the rectangular plate components into a Fourier series and finding the forces at the junction resulting from unit Fourier components of the edge displacements and rotations. The effect of rotating the edge of the rectangular slabs, and deflections of these edges normal to their original plane are found from plate theory. The effect of deflections of the edge in the planes of the component plates is found from two-dimensional elasticity theory. These influence coefficient functions are tabulated.

A sample three-plate structure is analyzed by the authors using the first three symmetrical modes of the displacement Fourier series.

Reviewer notes that the method would become quite unwieldy if a larger number of Fourier terms would have to be included, although this difficulty could be eliminated by the application of digital computation techniques. Although the method is somewhat cumbersome, it is a solution of a very complicated problem.

A. L. Ross, USA

187. Au, T., Ultimate strength design of rectangular concrete members subject to unsymmetrical bending, *J. Amer. Concr. Inst.* **29,** 8, 657–674, Feb. 1958.

The procedures of proportioning rectangular reinforced-concrete sections subjected to unsymmetrical bending in two directions based on ultimate strength method are formulated and discussed. To simplify design computations, charts are provided for determining dimensions of the equivalent compressive stress block after dimensions of the section and the arrangement of the reinforcement are assumed. Thus, the stresses in the tensile steel can be checked to verify the validity of the assumed section. The charts can be conveniently applied to sections subject to unsymmetrical bending with or without compressive force.

From author's summary

188. Geminard, L., Practical method for calculating a lattice girder with transverse bracing located outside the median plane of the members (in French), *Publ. int. Assn. Bridge. struct. Engng.* **17,** 47–57, 1957.

Two parallel members defining a plane P are joined by a series of portal frames having their median planes perpendicular to the plane P and to the members.

The girder thus formed is loaded in the plane P, perpendicularly to the members, by static or moving loads. The girder is required to have adequate stability without it being necessary to provide diagonal wind-bracing.

The assembly does not constitute a plane system. The deflection of this structure is complicated by the fact that the uprights of the various portal frames are subjected to both torsional and bending stresses, their transverse bracing is subjected to a skew bending and the members themselves are subjected to a torsional stress, and furthermore their deflections in the plane P are unequal.

The guiding principle of the approximation method consists in taking these various phenomena into account in order to reduce the problem, with a margin of error that is reasonable for the purposes of construction, to that of a conventional Vierendeel girder with parallel members. From author's summary

189. Zaid, M., Concerning the rigidity of elastic structures, *J. aero. Sci.* **25,** 2, 141–142 (Readers' Forum), Feb. 1958.

Book—190. Umanskii, A. A., Statistics and kinematics of frames [Statika i Kinematika Ferm], Moscow, Gosudarstvennoe Izdated'st'o Tekhniko-Teoreticheskoi Literatury, 1957, 342 pp.

Text is intended for students and designers with a substantial background in theoretical mechanics on college level. Teachers of mechanics may find this text useful. Advanced students of descriptive geometry may appreciate techniques involving vector and motor representation.

Author's lectures and investigations on statically determinate plane and space frames and shells are systematically presented in seven chapters. Author carefully credits previous contributions (from 1885 to 1955) and provides rather detailed bibliography for each chapter. He does not duplicate the theoretical material which appears in established texts on structures with the exception of occasional illustrative examples.

Considerable attention is devoted to kinematic methods of design and to finding displacements.

An effort is made to combine contemporary techniques employing virtual displacement theories, methods of limiting equilibrium, analytical and graphical techniques and special transformation methods known as model methods which considerably simplify solution and appear to be logical application of polar transformations. By latter method space frame is transformed into two-dimensional cases.

Author further advances A. Makarov's techniques for shells or thin-skin frames and their application to aircraft.

Considerable attention is given to theory of motors, also known as screws or kinematic screws. Motor is an equivalent of a system of sliding and free vectors such as moments and forces; angular and linear small displacements; angular and linear velocities; etc. In this interesting treatment author elaborates on the fundamental sense of motor operation—the scalar multiplication of motors. Structural mechanics in terms of motor algebra appears to be more elegant than in vector notation. Motors have two invariants which readily identify the state, such as equilibrium, rotation, etc.

Author brings out original techniques by B. Mayor, W. Prager, R. Mises, and others, and further develops special graphical techniques and grapho-analytical methods in vector and motor notation.

V. A. Valey, USA

191. Todorow, M., Iteration method of analyzing continuous beams and frames with undisplaced joints (in German), *Bautechnik* **35,** 1, 21–22, Jan. 1958.

New type of moment distribution method of continuous beams without elastic supports and frames without lateral swaying is presented and clarified by numerical examples. Although theoretically correct, this and all similar methods using the principle of moment distribution have the disadvantage of less accuracy which depends on the number of iterations. Principal disadvantage of these methods can be expressed by two facts: 1. Accuracy of the results can be checked only after all calculations are completed. If errors are found, the whole analysis must be repeated from very beginning. There is no possibility to check the correctness of the solution during the calculation. 2. These types of structures are usually designed for several most unfavorable loading conditions, and the calculations of all moment distribution methods (structural analysis) must be repeated for every different loading. Other methods of analysis have the advantage that accuracy can be checked at each stage of calculation, and basic factors of analysis are determined right at the beginning and are valid for any type of loading (e.g. method of fixed points, method based on properties of ellipse of elasticity, etc.). References are made to Hardy Cross, Grinter, Johannson

J. J. Polivka, USA

192. Gutierrez, J. N., Calculation of knot displacement of a plane structure (in Spanish), *Inst. tech. Constr. Cem. Publ.* no. 186, 44 pp., 1958.

The calculation of knot displacements of a structure loaded only in knots, and in which these knots can displace but not rotate, is made in analytical form. It is reviewer's opinion that for statically indeterminate structures with skew bars this method could be applied in solving them using as unknowns rotations and translations of knots or using the Cross method.

In some cases the method results in an analytical substitution of Williot's diagram. A. J. Bignoli, Argentina

193. Fanelli, E., Application of a method of Colonnetti for the calculation of an arch attached to a frame (in Italian), *Cons. naz. Ricer.* no. 481, 23 pp., 1957.

An elastic analysis is made of an arch supporting a horizontal beam by means of a number of hinged vertical columns; concentrated vertical forces are assumed to act at the panel points. Titular method is analogous to that of Muller-Breslau and is used to determine vertical displacement of arch.

G. W. Housner, USA

194. Iskritsky, D. E., Calculation of bar frames by the triangle method (in Russian), Zap. Leningr. zaoch. industr. in-ta. Leningrad, Leningrad State University, 1955, 23–53; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3621.

195. Kabùlov, V. K., Calculation of stone walls of buildings for the action of inertia forces in their planes (in Russian), *Trudi in-ta sooruzhenii Akad. Nauk UzSSR* no. 6, 41–51, 1955; *Ref. Zh. Mekh.* no. 4, 1957, Rev. 4678.

A method is given for the conventional calculation of walls for the action of horizontal seismic loads in their planes. The summated stress T acting on the longitudinal wall taking the stress P of the upper floors is determined from the formula $T = \alpha k_s$, where k_s is the seismic coefficient, and α is a coefficient dependent on the dynamic characteristics of the building. The total stress T is distributed over the partition walls proportionally to their rigidity. Tables are given. N. A. Rostovtsev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

196. Rebrov, L., Evaluation of the interaction of foundations and stresses in the foundation soil and on settlement along influencing lines (in Russian), *Sb. rabot stud. nauch. o-va Penzensk. industr. in-ta* no. 3, 3–9, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3549.

To evaluate the interaction between adjacent foundations a method is presented for a conditional engineering calculation with the help of influence lines plotted by the Boussinesq formula for the stresses σ_z caused by a concentrated load on the boundary of an elastic semispace. M. A. Rostovtsev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Structures: Composite

(See also Revs. 19, 20, 22, 100, 116, 182, 183, 186, 234, 523, 542, 553, 554, 561)

197. Sih, N. S., Torsion analysis for suspension bridges, *Proc. Amer. Soc. civ. Engrs.* **83,** ST 6 (*J. Struct. Div.*), Pap. 1431, 9 pp., Nov. 1957.

Torsional load and resulting stresses, especially during erection of suspension bridges of long span and greater width, and also for other types of bridges, may become critical and should be considered in the design. Author derives equations determining these stresses in stiffening trusses, considering cable interaction and the effect of warping. For simplicity the cross section of the bridge is assumed as uniform and symmetric about the center of the section. Analysis refers to torsion of cross section with double lateral system without and with cable interaction. Following values are determined: angle of twist, additional cable tension, also when warping is neglected and the cable curve is assumed as parabolic, shear in truss cross section. Presented method is applied to a suspension bridge 90 ft wide, spanning 2000 ft, with following characteristics: (a) Uniform torque due to live load on one side of the bridge; (b) asymmetric uniform torque, under which the section at the center of the bridge remains fixed with respect to rotation and longitudinal displacement.
J. J. Polivka, USA

198. Hiba, Z., Concerning the statistics of anchored suspension bridges (in German), *Stahlbau* **26,** 4, 113–115, Apr. 1957.

Stiffening trusses of suspension bridges, especially of smaller and medium spans, are often assembled of prefabricated sections, and it can happen that due to not perfect interconnection of individual members the bending safety is unfavorably affected and sagging can occur without considerable stressing. These conditions are more thoroughly investigated. In addition, the known approximation method published in Stahlbau-Handbuch, 1948, is discussed and improved by introducing a factor expressing the reduced bending strength of stiffening trusses due the aforementioned construction method. Numerical example of an anchored suspension bridge spanning 57.91 m (190 ft), with 0.9 t/m deadload and 10 t/m liveload, shows that horizontal thrust due to liveload acting upon the first quarter of span (10 t/m) increases under certain possible assumptions from 47.7 t to 65 t (38%), if calculated in accordance with author's improved method, thus securing greater safety of design. J. J. Polivka, USA

199. Selberg, A., Aerodynamic stability of suspension bridges (in English), *Publ. int. Assn. Bridge struct. Engng.* **17,** 209–216, 1957.

By use of diagrams the critical wind velocity may be found within a limit of ±10%. Considering the uncertainties connected with the wind this should be more than sufficient for most cases.
From author's summary

200. Courbon, J., Calculation of bridges with overhung girders connected by joints (in French), *Publ. int. Assn. Bridge struct. Engng.* **17,** 9–22, 1957.

The method of calculating bridges with overhung girders connected by joints is based on the existence of a linear relationship between the shearing stresses at right angles to three successive joints. This relationship makes it possible to define transfer factors which facilitate the calculation, since it is no longer necessary to solve series of linear equations.

Bridges with overhung girders connected by joints are low-cost constructions which are particularly well-adapted to the application of prestressed concrete. In that case they may be built as cantilevers without employing centering.
From author's summary

201. Dabrowski, R., Stability of a single-girder bridge (in Polish), *Rozpr. Inzyn.* **5,** 4, 581–634, 1957.

The principal object of this paper is the solution of the problem of stability of a bridge composed of a single arch and a stiffening beam connected with the arch by means of hangers. Torsional buckling of the arch, which is of monosymmetric cross section, is taken into consideration, rigid joints between the hangers and the arch of the beam being assumed.

Using differential equations derived by the author and assuming sine functions for solutions of these equations, he obtains a formula determining the value of the critical force for buckling.

Next, the calculation of stability of the system by means of the energy method is presented taking variable rigidity of the hangers into consideration. In the second part of the paper the strength of the system is discussed in the case of one-side load. The last part is devoted to the problem of vibration of the system considered.

Finally, some numerical examples are given concerning the problems treated. J. Czulak, Poland

202. Shestakov, A. V., The influence of the outline of the axis of a rigid bridge arch on the stress under transient load (in Russian), *Trudl. Khabarov. in-ta inzh. zh. -d. transp.* no. 9, 112–166, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3574.

203. Hilly, Y., Note regarding so-called effective slip lines in a triangular concrete dam (in French), *Houille blanche* **12,** 4, 536–539, Sept. 1957.

204. Abeles, P. W., Impact resistance on prestressed concrete masts (in English), *Publ. int. Assn. Bridge struct. Engng.* **17,** 1–7, 1957.

Comparative tests are described which were carried out by British Railways, Eastern Region, 1955, to investigate the impact resistance of steel and prestressed concrete masts. Each type became entirely unserviceable at a direct hit by a 20-ton wagon projected into the mast with a speed of 10 miles/hour, but remained temporarily serviceable at a glancing blow. Further, the suitable shape of prestressed concrete masts is discussed in connection with appropriate design considerations and, finally, 20-years' experience in Austria with nonprestressed spun-concrete

masts with high strength steel reinforcement is reported as satisfactory in spite of unavoidable fine hair cracks.

From author's summary

205. Golubovic, G., Aerodynamic study of a cooling tower in the form of a hyperboloid of revolution (in French), *Publ. int. Assn. Bridge struct. Engng.* **17,** 87–94, 1957.

Author examines the effect of several parameters on the problem of the distribution of pressure around a hyperboloid of revolution subjected to wind loading. On the basis of the similitude theory, rules are worked out for the transfer to full scale of experimental results obtained on a model. The model constitutes a geometrical replica of a cooling tower of hyperbolic form. The parameters investigated are the geometrical shape and the location of the series of ribs placed on the outer surface of the tower.

From author's summary

206. Wituszynski, K., Stability and strength of a framed corrugated steel sheet (in Polish), *Rozpr. Inzyn.* **5,** 4, 513–545, 1957.

Paper is concerned with a problem very important for the shipbuilding industry, the problem of load-carrying bulkheads of corrugated steel sheets in tankers built in Polish shipyards.

The present investigation of such a bulkhead is based on the theory of oblique tension in sheets loaded above the limit of elastic stability. The orthotropy of the corrugated sheet is taken into consideration as well as the appearance of stress concentrations and the rapid attainment of the yield point at the corners of trapezoidal waves (with small roundings), particularly disadvantageous from the point of view of strength. The theory of oblique tension being not very accurate, the assumption of a simplified stress distribution is justified. A nonuniform distribution of the horizontal components of the oblique tension stresses is assumed, while the vertical ones are assumed to be constant. In order to overcome the calculation difficulties, a substitute nonhomogeneity of the coefficient E for vertical tension is assumed (caused by the appearance of the buckling waves in the central part of the sheet). Therefore the stress trajectory of the oblique load is not rectilinear but S-shaped. A number of diagrams facilitate the calculation of the limit load for a sheet framed by sufficiently rigid stiffenings.

J. Naleszkiewicz, Poland

207. Shimansky, Yu. A., The proper selection of the metacentric height in ship designing (in Russian), Sb. statey po sudostroyeniyu, Leningrad, Sudpromgiz, 1954, 121–127; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3099.

Paper deals with the general questions of the seaworthiness of a ship in relation to the value of its metacentric height.

Author expresses his disagreement with the decision taken earlier by the Technical Committee of the former Russian Register of Shipping concerning the determination of the characteristics of petroleum tankers to be built by the former (Russian) Petroleum Syndicate, and points out the necessity of carefully considering the value of the transverse metacentric height to be assigned to a vessel. He suggests to distinguish between the case of a warship, to be regarded as a gun platform; a passenger ship, for which the main consideration must be the physiological effect of the pitching and rolling motion on persons; and the cargo-carrying ship, which only requires to satisfy the condition of minimum floodability and access to machinery and equipment. Dealing with the last-named subject in more detail, author comes to the conclusion that the seagoing properties of a ship will be the better, the greater its transverse metacentric height. In any case, the value of this factor must insure a period of free oscillation of the ship of less than 6 seconds (a period of oscillation between 6–14 seconds is considered particularly disadvantageous in regard to the seaworthiness and seakindliness of a ship).

N. N. Babaev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

208. Batdorf, S. B., Structural problems in hypersonic flight, *Jet Propulsion* **27,** 11, 1157–1161, Nov. 1957.

An interesting survey is given on the situation the stressman is confronted with in problems associated with hypersonic flight, problems related with aerodynamic heating being the main sources of his troubles. Thermal stresses introduced by transient variations in temperatures are briefly discussed. A review is given of the creep problem and its difficulties, which can be summarized to the statement that accurate prediction of the behavior or structures under variable loading conditions at high temperatures is impossible at present, the necessary stress-strain-time-temperature relation required as a substitute for the stress-strain relation of the theory of elasticity not being in general known. The loss of strength of metals and alloys at elevated temperatures is discussed and some metallurgical aspects of the problem of hardening are described. It turns out that improvements in high-temperature strength are generally associated with reduction in ductility so that thermal shocks become a problem. In a section on strength of nonmetals some characteristics of ceramics and cermets are given and the effects of thermal shocks on two skin materials of different diffusivity are compared at two flight conditions. As regards stiffness, a problem in high-speed flight quite aside from aerodynamic heating, the problem is accentuated when temperature rises. Young's modulus, a measure of the stiffness of structural materials per unit volume, may be reduced to half its room temperature values near the upper end of the useful temperature range of typical alloys.

H. Behrbohm, Sweden

209. Nicholson, L. F., Engine-airframe integration, *J. roy. aero. Soc.* **61,** 563, 711–726, Nov. 1957.

210. Jenkins, L. R., Leakage rates from a pressurized aircraft at altitude, *J. roy. aero. Soc.* **61,** 563, 776–779, Nov. 1957.

211. Charlton, T. M., The analysis of structures with particular reference to the prediction of deflexions, *N. E. Cst. Instn. Engrs. Ship. Trans.* **74,** 3, 164–188, Jan. 1958.

Machine Elements and Machine Design

(See also Revs. 73, 486, 586)

212. Goodman, T. P., Linkages vs. cams, *Mach. Design* **30,** 17, 102–109, Aug. 1958.

213. Shipley, E. E., How to predict efficiency of gear trains, *Prod. Engng.* **29,** 31, 44–45, Aug. 1958.

214. Howell, J. D., Cantilever springs, *Prod. Engng.* **29,** 27, 58–59, July 1958.

Providing a curved support for a cantilever protects it from overstress and triples its energy capacity. This article presents design equations and details covering seven types of cantilever springs that roll with the load.

From author's summary

215. Hinkle, R. T., and Morse, I. E., Jr., Design of helical springs for minimum weight, volume, and length, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-9, 4 pp.

In the design of helical springs where the load, deflection, allowable stress, and material are specified, there are an infinite number of solutions. In this paper, equations and graphs are presented for the selection of a spring index that will result in a spring of minimum weight, volume, or length. If, in addition to these requirements, the inside or outside diameter of the spring

is fixed, there is only one solution. Equations and graphs are included for the selection of the spring index which will satisfy this additional requirement. From authors' summary

216. Bert, C. W., Helical springs of hollow circular cross section, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-18, 6 pp.

Paper presents two analyses for shear stress and deflection in an axially loaded helical spring of hollow circular cross section; the first is an approximate solution by strength-of-materials methods, the second a more accurate solution by theory of elasticity. The two analyses are compared with each other and with Reissner's solution for an infinitely thin-walled spring. Results of author's theory-of-elasticity solution are compared with experimentally determined strains and deflections, the agreement being excellent. Convenient design formulas for stress and deflection are listed. R. J. Roark, USA

217. Khvingiya, M. V., Determination of the torsion angle of conical springs (in Russian), *Trudī Gruz. politekhn. in-ta* no. 34, 103–110, 1954; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 2462.

The relative angular shift of the butt ends of conical springs under compression is investigated. Convenient approximate relations are given. It is established that conical springs having the form of Archimedean spirals in plane are much more liable to torsion than conical springs coiled in the form of logarithmic spirals. An investigation is made of the relative linear and angular shifting of the butts of conical springs when they are loaded with compression forces and torsion moments.

S. D. Ponomarev
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

218. Nitsche, C., Electromagnetic multi-disk clutches, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-61, 7 pp.

Advantages, installation details, and performance of an electromagnetic multi-disk clutch are described. Results of experiments carried out on different types of outer and inner disks, and their influence upon the torque characteristic and release times are published. The main advantage of a multi-disk clutch is its small package dimensions in relation to the magnitude of the transmitted torque. The clutch, being an element suitable for remote control, has been adopted readily by the gearbox designer, enabling him to dispose of a number of mechanical speed- or direction-changing features. Basically, two types of electromagnetically operated clutches are known: (a) In which the magnetic flux passes through the disk stack; (b) in which the disk stack is not in the path of the magnetic flux. From author's summary

219. Leonard, E. V., Spring clutches for faster response, *Prod. Engng.* **29,** 15, 57–59, Apr. 1958.

Essence of the idea is a helical spring bridging input and output shafts. Article describes applications and works out an example where spring clutch shows its advantages for high-speed indexing. From author's summary

220. Hain, K., and Marx, G., How to replace gears by mechanisms (linkages), ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-33, 5 pp.

A practical method is shown for designing four-bar mechanisms having a prescribed transmission ratio held within prescribed tolerances, for a limited range of motion. Such mechanisms may economically replace gears in many applications. Charts enable the designer to choose the mechanism having the best transmission angle possible. From authors' summary

221. Allen, C. W., The design of linkages to generate functions of two variables, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-57, 9 pp.

Graphical methods are presented for designing linkages that have two inputs and one output. Two basic approaches are developed. The desired function is matched at a limited number of positions, with the maximum number being seven. Designs also are developed which match the derivatives of the desired function at a single point. The designs were developed with ease of solution and broadness of application as primary considerations.

From author's summary

222. Rosenauer, N., Synthesis of drag-link mechanisms for producing non-uniform rotational motion within prescribed reduction ratio limits, *Austral. J. Appl. Sci.* **8,** 1–6, 1957.

A drag-link mechanism is a four-bar linkage in which the shortest linkage is fixed and both cranks move in the same direction. Author asks for a linkage in which one crank is rotating uniformly and the extreme values of the output angular velocity are prescribed. A solution is given by means of complex numbers and a numerical example added. O. Bottema, Holland

223. Tainov, A. I., Kinematic couples as links (in Russian), *Sb. nauch. tr. Belorus. lesotekhn. in-ta* no. 8, 230–242, 1956; *Ref. Zh. Mekh.* no. 4, 1957, Rev. 3948.

It is suggested that the class of a kinematic couple should be considered equal to the number of degrees of freedom in the relative motion of its members. Various forms of actually realizable kinematic couples are examined. Author contradicts his classification, referring the worm couple to the fifth class.

S. G. Kislitsyn
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

224. Guseinov, N. M., One problem in the synthesis of four-link mechanisms (in Russian), *Trudī Azerb. s.-kh. in-ta* **4,** 95–100, 1955; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1526.

Paper is devoted to the exposition of S. A. Chertudinova's method [*Trudī Seminara po teorii mashin i mekhanizmov in-ta mashinoved. Akad. Nauk SSSR* **3,** no. 9, 1947] in its application to the mechanisms bringing into movement the screen for cleaning the grain in combines. I. I. Artobolevskii
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

225. Panteleev, S. I., Structure, kinematic investigation and some problems in designing spatial mechanisms of linked levers (mechanisms of aviation apparatus, exact calculating machines and automation) (in Russian), Avtorefer. diss. kand. tekhn. nauk., Mosk. aviats. in-ta, Moscow, 1956; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 180.

226. Aksel'rod, Z. M., Theoretical and experimental investigation of clock mechanisms with free lever escapement and small period of oscillation of the balance (in Russian), *Sb. statei Leningr. in-ta tochnoi mekh. i optiki* no. 17, 3–29, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 152.

The examination of clock mechanisms with small oscillation periods has as its object their adaptation for the measurement of small time intervals. By means of integration of the nonlinear equations of the oscillation system of the mechanism, in which constant friction and resistance are assumed proportional to the square of the speed of the balance, formulas are obtained allowing a calculation to be made of the dependence of the increase of the oscillation period of the balance on the amplitude, and the dependence of the amplitude on the torque of the escape wheel. Analysis of these formulas shows that to safeguard the isochronism when the period of oscillation of the balance is reduced (by means of reducing its moment of inertia and of increasing the stiffness of the hair spring) it is essential to increase the torque of the escape wheel. The experimental investigation is described,

supporting the theoretical results. The smallest attained period of balance oscillation in clocks with free lever movement comprised 0.0047–0.0030 secs. The starting arrangement in apparatus for measuring small intervals of time should transmit to the balance an initial amplitude as nearly as possible equal to the steady amplitude. A. S. Alekseev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

227. Riftin, L. P., Investigation of some parameters in clock movements (in Russian), *Sb. statei Leningr. in-ta tochnoi mekh. i optiki* no. 17, 75–91, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 153.

Points investigated were the smoothness of transmission, determination of the coefficient of useful work (efficiency), and the limits of its variation, determination of the maximum value of the gear ratio for one pair of toothed wheels.

A. S. Alekseev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Fastening and Joining Methods

(See also Revs. 76, 146, 153)

228. Hebrant, F., Tests on assemblies with stretched bolts or rivets (in French), *Publ. int. Assn. Bridge struct. Engng.* **17,** 95–116, 1957.

The purpose of the tests was to define precise rules for dimensioning riveted assemblies in which the rivets are subjected both to tensile and shear forces and also to compare the static and fatigue strengths of assemblies of this type comprising rivets, ordinary bolts or high-strength bolts more or less prestretched.

Tests on single rivets subjected simultaneously to tensile and shear forces enables a criterion of static rupture to be established in the form

$$\sqrt{\sigma^2 + 1.5\,\tau^2} = R_r.$$

The actual tests were carried out on triangular brackets fixed to a column and subjected to a force acting parallel to the plane of the assembly. The chief conclusions drawn from the tests are as follows:

(1) The two conventional methods for dimensioning these assemblies give reliable results, provided the calculations are based on the cross section of the bolts at the bottom of the threads.

(2) The use of prestretched high-strength bolts makes it possible, as compared with a riveted assembly, to gain (a) twenty per cent on the static strength of the assembly and (b) up to one hundred per cent on its fatigue strength; the last-mentioned gain increases with the extent of the prestretching and is a maximum when the prestretching tension reaches the elastic limit of the bolts. From author's summary

229. Ginsburg, Ya. S., The problem of relaxation tests on bolted joints (in Russian), *Zavod. Lab.* **22,** 5, 584–585, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3705.

230. Mills, W. C., Sheet metal seams and joints, *Prod. Engng.* (Design Digest Issue) **28,** 15, G8–G11, Oct. 1957.

231. Spraragen, W., Preheating—residual stresses—stress analysis, *Welding J.* **37,** 1, p. 21s, Jan. 1958.

232. Armstrong, T. N., and Warner, W. L., Effect of preheating and postheating on toughness of weld metal, *Welding J.* **37,** 1, 27s–29s, Jan. 1958.

Test program was set up to investigate the effects of preheating and postheating on the transition temperature for weld metal from seven classes of steel electrodes.

From authors' summary

233. Degarmo, E. P., A theory for preheating of plain, low-carbon steels, *Welding J.* **37,** 3, 93s–96s, Mar. 1958.

Improved weldment performance which, under many conditions, results from preheating is attributed by the author primarily to reduced microcracking. From author's summary

234. Sutherland, R. A., Symposium on welded spiral cases from the consulting engineers' and users' viewpoint, *Trans. ASME* **80,** 5, 1143–1145, July 1958.

235. Palii, O. M., Determination of the deformation of plates when fillets are seam-welded along its edges (in Russian), *Tr. Leningr. korablestroit. in-ta* no. 11, 165–176, 1953; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 2468.

A method is given for determining the deformations produced by the welding of a fillet on the edge of a plate, which is the outcome of the equations of the plane problem of the theory of elasticity; in particular, use is made of Bel'zetskii's solution [see P. F. Papkovich, "Theory of elasticity," 1939, page 414]. The distribution of temperature in section is determined in agreement with N. N. Rykalin's theory regarding distribution of heat in welding ["Thermal calculations for welding processes," Mashgiz, 1951]. V. S. Ignat'eva

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

236. Miller, F. M., Thermal analysis of brazing and hard-surfacing alloys—a proposed method, *Welding J.* **36,** 10, 986–991, Oct. 1957.

Procedure advanced by author is described as being a simple, practical, and accurate means for determining liquidus and solidus temperatures for brazing and hard-surfacing alloys which melt within the range 1600 to 2100 F.

From author's summary

237. Jones, J. B., and Potthoff, W. C., Ultrasonic soldering, brazing and welding, *Prod. Engng.* (Design Digest Issue) **28,** 15, G14–G16, Oct. 1957.

238. Strauss, R., and Barnes, A. F. C., Stationary wave soldering of printed circuits, *Prod. Engng.* (Design Digest Issue) **28,** 15, p. G17, Oct. 1957.

Rheology

(See also Revs. 62, 184, 442)

239. Gamski, K., Representation of rheological properties with mechanical models (in French), *Rev. univ. Min.* (9) **101,** 4, 122–132, Apr. 1958.

Although this review of some areas of viscoelasticity and non-Newtonian flow does not include much of the work published in English during the past decade, it does mention some French language publications not often referenced here.

A rather interesting (one-dimensional) model due to Torroja and Paez (5th Congr. of Bridges and Timberwork, Lisbon 1956) attempts to permit incremental permanent set at each cycle of periodic loading. As with some other parts of the paper, the exposition of this model was not clear to the reviewer, either dimensionally or physically. S. Corrsin, USA

240. Saito, N., and Kato, T., On the viscoelasticity and complex dielectric constant in the presence of an electric field and a shearing laminar flow in solution of macromolecules, *J. phys. Soc. Japan* **12,** 12, 1393–1402, Dec. 1957.

241. Slibar, A., and Paslay, P. R., Axial flow of Bingham fluids in concentric tubes (in German), *ZAMM* **37,** 11/12, 441–449, Nov./Dec. 1957.

The flow and velocity field for a material known as Bingham plastic is found by using three-dimensional stress-deformation-velocity relations. The calculation shows that between cylindrical boundaries a concentric part of the material flows with uniform velocity. A graphical representation is given of the numerical results of some calculations pertaining to problems such as occur in deep-well drilling.

From authors' summary by D. Kececioglu, USA

242. Parfitt, G. G., Damping in rigid high polymers (in English), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **5,** 360–367.

There are two ways in which the structure of polymers can be idealized for the purposes of calculation, which consider, respectively, (a) chain segments of various length moving in a medium, essentially uniform and viscous; (b) single type of segment or molecular group located in various environments. Method (a) is appropriate to the rubber-like and transitional states with fairly free molecular motion, and it has been widely applied. In the rigid or glassy state, where the molecules are fairly but randomly packed, method (b) is more suitable. Paper presents theory of mechanical damping in a high polymer in the state (b), based on the concept of mechanical relaxation occurring in small regions of lower packing density within the structure, and possible treatment of this type, prompted by experiments which indicated a strong dependence of damping on free volume, frequency and temperature.

J. J. Polivka, USA

243. Tyabin, N. V., The unsteady flow of a viscous-plastic disperse system in a lamina between two coaxial, cylindrical tubes, and in a cylindrical tube (in Russian), *Trudi Kazansk. s.-kh. in-ta* no. 35, 213–225, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3120.

The first problem examines the circular motion of a viscoplastic fluid (allowing for the limiting shear stress); in the second, the rectilinear motion between two coaxial cylinders. In both cases, a combined solution is given for the differential equation of motion of the inside cylinder and the differential equation of motion of the medium, with account of the local time derivative of the velocity in an averaged form [N. A. Slezkin and S. M. Targh, *Dokladi Akad. Nauk SSSR (N.S)* **54,** no. 3, 1946]. A third problem examines the unsteady motion of a viscoplastic medium in a circular, cylindrical tube, also by applying an average acceleration value. A comparison is made between the analytical curve of change of moment of the frictional forces in time, and the experimental values; on the "starting length," the divergence between the two curves is considerable.

N. A. Slezkin
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

244. Mirzoyan, A. A., A solution of two partial problems of the hydrodynamics of a viscous plastic fluid (in Azerb.), *Izv. Akad. Nauk Azerb. SSR* no. 11, 13–18, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3118.

The steady rectilinear motion is examined of a viscous plastic fluid (with allowance for the limiting shear stress) between two coaxial, circular cylinders, on the condition that the velocity in the nucleus is constant. The radii of the nucleus are determined approximately, on the assumption that the gap between the cylinders is small. An approximate solution is given for the problem of the motion of a viscously plastic fluid between cylindrical heating surfaces.

N. A. Slezkin
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

245. Mirajanzade, A. Kh., and Abbassov, A. A., An approximate solution for the problem of the unsteady motion of a viscously plastic fluid in a circular, cylindrical tube (in Russian), *Dokladi Akad. Nauk SSSR (N.S.)* **107,** 2, 249–251, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3119.

A comparison is made between the rigorous solution of the problem of unsteady flow of a viscous, incompressible fluid in a circular, cylindrical tube and the approximate solution of the same problem by the method of averaging the accelerations [N. A. Slezkin, S. M. Targh: title source **54,** no. 3, 1946]. Using the same approximation method, a solution is constructed for the problem of the motion of a viscous-plastic fluid in a cylindrical tube. The results of the numerical calculations are tabulated.

N. A. Slezkin
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

246. Hill, R., New horizons in the mechanics of solids, *J. Mech. Phys. Solids* **5,** 1, 66–74, Nov. 1956.

Examples of relations between theories of different solids and fluids are given to indicate the need for a broader systematic development than now available. Uniqueness and extremum principles are discussed and related to each other for nonlinear viscous fluid, ideally plastic, Bingham viscoplastic, and nonlinear elastic solids. Viscoelasticity, work-hardening, plasticity, and creep also are considered.

Exact correspondences between field equations of elasticity and viscosity, stress and velocity equations for quite general constitutive laws, and plastic flow and compressible fluid mechanics are discussed.

Situations in which certain aspects of the general problem correspond include viscoelasticity and elasticity, elastic-plastic and rigid-plastic solids, and bodies exhibiting yielding in a general sense.

Need for generalizing definition of an idealized body to obtain uniqueness is discussed by considering ideal plasticity as the limit of vanishingly small work hardening.

E. H. Lee, USA

247. Krasil'nikov, Yu. I., Unsteady motion of viscoplastic liquid in a pipe (in Russian), *Prikl. Mat. Mekh.* **20,** 655–660, 1956.

The problem considered is that of a flow of a viscoplastic (incompressible) liquid in a straight cylindrical pipe. The fundamental general set of equations used is that derived by G. Genki [*On slow stationary flows in plastic media,* Theory of plasticity (Yu. N. Rabotnov, ed.), Gos. Izdat. Inostran. Lit., 1948] reduced to the two-dimensional case in cylindrical polar coordinates with only the longitudinal velocity component being preserved. The inertia terms are neglected so that the equation is linearized. The surface stress tensor consists of two parts: elastic and viscous stress tensor. The initial condition superimposed upon the velocity is that as $t = 0$ it must be equal to the given function of the radius. The boundary condition is that the velocity is zero at the wall of the pipe. Author proposes a solution for the velocity in form of the sum of two series with, for the time being, unknown coefficients, one of which is a trigonometric series and another a Fourier-Bessel series, subject to the corresponding initial and boundary conditions. By means of suitable manipulations, author obtains workable equations for the coefficients of the series. As a particular case Krasil'nikov considers the flow with constant pressure difference and derives the final formulas

for the velocity and flux at $t = 0$ and $t = \infty$. The reader is warned that the symbol ρ is used in double meaning; density and radius. M. Z. Krzywoblocki, USA

Hydraulics

(See also Revs. 210, 522, 541, 551, 559, 561, 585)

Book—248. Smetana, J., Hydraulics, I [Hydraulika, I] Praha, Nakladatelstvî Československé Akademie věd, 1957, xxxii + 544 pp.

The first volume of a monumental treatise concerns physical properties of liquids, statics, kinematics and dynamics of liquids, and the steady flow of water in pipes and channels. Among particular chapters may be mentioned: systems of units, equilibrium in a potential field, liquid pressure, stability of floating bodies, fundamental laws of kinematics, dynamics, friction, impulse-momentum, turbines, dimensional analysis and similarity, theory of turbulence, boundary layer, resistance to flow, water flow in industrial channels, natural channels and silt transport, nonuniform flow.

Author, one of leading European scientists in hydraulics and hydrology, makes a successful attempt to include into his treatise the newest achievements of Russian and European authors. List of references contains 196 titles in many languages.

S. Kolupaila, USA

Book—249. Smetana, J., Hydraulics, II [Hydraulika, II] Praha, Nakladatelstvî Československé Akademie věd, 1957, xx + 490 pp.

Second volume of the treatise is dedicated to 250th anniversary of the technical school in Prague. It covers nonuniform flow—orifices and weirs, hydraulic jump, unsteady flow through orifices, unsteady flow in open channels, water impact and surge reservoirs, potential flow, flow net, electric analogy, conformal transformation flow through porous media. Both Russian and European views are presented; some American methods are also included.

Book is written for advanced students and perfectly edited; few errors are to be corrected, such as Uginčus instead of Ugničus, Gluškov instead of Glučkov. It is one of the most modern European books on hydraulics. Bibliography contains 196 titles in all languages. S. Kolupaila, USA

Book—250. Dub, O., Hydrology, hydrography, hydrometry [Hydrológia, Hydrografia, Hydrometria] Bratislava, Slovenské Vydavatelstvo Technickej Literatúry, 1957, 485 pp.

This perfectly edited book is the first on hydrology in Slovak language. It includes research methods, climatic factors of water circuit, surface water runoff, silt transportation and measurement, underground waters, lakes and swamps, water quality. Text is based mostly on works of Russian hydrologists, not eliminating, however, American and European methods. Thus it can be regarded as a survey of this science from all over the world. Author, who also wrote "Limnology," 1953, and "General hydrology of Slovakia," 1954, can be complimented for a comprehensive compilation of interesting hydrologic material, mostly of local observations. Statistical methods are used to a great extent. Some conditional statements are questionable; e.g., that water and channel form "a dialectic unity" and cannot be studied separately. Several mistakes can be explained by lack of original foreign sources; H. A. Foster is identified as E. E. Foster, the Thiessen method is credited to R. E. Horton. Bibliography is mostly in Russian and Czech language. No English titles are mentioned.

S. Kolupaila, USA

251. Kuperman, V. L., Surge tank hydraulics in power plants with penstocks (Method similar to Ch. Jaeger's) (in Russian), *Gidrotekh. Stroit.* **26,** 12, 24–30, Dec. 1957.

252. Matsuev, L. P., Theoretical bases of separation in sluices (in Russian), *Kolyma,* no. 1, 21–26, 1956; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 2095.

Some empirical correlations are proposed, enabling the carrying out of calculations in gravity methods of enrichment. A formula is deduced for the determination of the mean flow velocity V_m corresponding to the beginning of the movement of the grains of mineral species in a pan (in "sluices") having the form

$$V_m = \frac{0.84\, V_o}{\sqrt{(d/H)^{\frac{1}{3}} + 0.0024}}$$

where V_o is the end velocity of the particles into an unlimited liquid medium; d is the diameter of the grain; H the depth of the flow.

Further, it is noted that all the grains of the field material, which have a "wash-out" velocity less than the mean velocity of the layer of water on the same level as the dimensions of these grains, will be washed off the pan together with the grains devoid of metal. An attempt is made to establish the interconnection between the coefficient of equal velocity, expressing the relation of the diameters of grains with different specific gravities, but liable to be washed off at one and the same mean velocity flow, and the coefficient of even rate of falling, expressing the relation of the diameters of the grains with different specific gravities, but having the same end velocity of free fall into an undelimited liquid medium. For the movement of the grains on the pan, the bottom of which is also made up of grains, the following formula is proposed

$$V_m = 1.633\,\lambda\,\Lambda\,\sqrt{d(\delta - 1)\,g}\left(\frac{H}{h}\right)^{\frac{1}{6}}$$

where Λ is the coefficient depending on the granulometric composition of the sands and determined by a special table, constructed by P. V. Lyashchenko [Gravity methods of concentration, 1940]; λ is the coefficient, depending on the form of the grains; δ is the consistency (density) of the grains: g is the acceleration of the forces of the earth's attraction; h is the height of the grains above the grain bed (above the bottom of the pan). There are a number of misprints and inaccuracies. A. N. Klimentov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

253. Semanov, N. A., Leakage of water from sluices and lock gates and combatting these losses (in Russian), *Trudî Leningr. in-ta inzh. vod. transp.* no. 22, 17–32, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 535.

254. Jaeger, L. G., The bending moments in a dock gate, *Civ. Engng. Lond.* **52,** 616, 1124–1126, Oct. 1957.

255. Frankovic, A., Pressure loss of liquids in uniform turbulent flow (in German), *Wasserwirtschaft* **48,** 3, 65–70, Dec. 1957.

Author refers to a general formula for the determination of the loss of head for uniform flow in the turbulent region. Based on experience for pipe lines, he develops an expression introducing the Reynolds numbers 2320 and 580 and, further, a coefficient corresponding to the profile. The good agreement with experimental research is also pointed out.

Reviewer believes that, for practical purposes, the formula by White-Colebrook, given also in explicit form by Supino, offers throughout good results. Its application for the flow with free surface may be possible accordingly, when the perimeter of the cross section is tangential to a semicircle. The influence of the shape of the cross section on the coefficients of resistance is, for example, stated by Marchi. Author's treatment may be considered for basic research work. P. Franke, Germany

256. Velikanov, M. A., The theory of channel flow and its significance for the structures of the fifth five-year programme (in Russian), "Problems of channel flows," Leningrad, Gidrometeoizdat, 1953, 9–15; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3249.

The fundamental problems are examined of the development of the hydrodynamical aspect in hydrology. In the opinion of the author, the investigation of channel flow processes should be based on the principle of the minimum energy dissipation.

The author's suggestions are presented for a new conception of turbulence in channels, as well as considerations on the simulation of channel flow processes.

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

257. Dzhimsheli, G. A., A generalized method of hydraulic computation of channels of polygonal cross section (in Russian), *Izv. Tbilissk. n-i in-ta sooruzh. i. gidroenerg.* **9**, 3–18, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 504.

Average values of $\bar{b}$, width, and of h, depth, are introduced as original parameters of the cross section. All the geometrical elements are expressed in relative values

$$\mu = \frac{b}{M_0 h} = \frac{l}{h}, \beta = \frac{b}{\bar{b}}$$

$$(M_0 = 2\sqrt{1 + m^2} - m)$$

where m is the coefficient of filling of the section, l the linear parameter. The calculation for the canals is carried out with the help of values μ and β. To simplify the calculation, graphs and tables are included. P. G. Kiselev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

258. Dzhimsheleishvili, G. A., A combined method of integration of equations for a nonuniform, slowly changing movement of liquid in open water currents (in Russian), *Trudi Azerb. industr. in-ta* no. 7, 94–101, 1954; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 503.

Author is of the opinion that defects in existing methods of calculating the problem are due to the introduction of one or two arbitrary averaging values. To improve the calculation he introduces a variable

$$\rho = (1 - j)\frac{1 - \eta^t}{1 - k^t}$$

(where η is the relative depth, j the value, proportional to the slope of the water current, k the value of the inversely proportional calculated discharge), which he then exhibits in the aspect of

$$\rho = \rho_0 + \theta\eta^t$$

Further an assumption is introduced to the effect that the value

$$\theta = \frac{\rho_2 - \rho_1}{\eta_2^t - \eta_1^t} \qquad [21]$$

can be replaced by constant $\bar{\theta}$, that is averaged when, as the author remarks, the corresponding investigation testifies to the smooth variability of $\theta = f(\eta)$. As regards the indicator of degree t, it can be deduced from equation [21] and, as shown by the author, it does not depend on the shape of the water stream; however, proof of this is not furnished.

The sum total of such an analysis of the solution leads to its being put forward in the form

$$i_0 \frac{S_0}{h_0} = \eta_2 - \eta_1 - \rho_0[D(\eta)]_{\eta_1}^{\eta_2} - \bar{\theta}[D(\eta) - \eta]_{\eta_1}^{\eta_2}$$

where

$$D(\eta) = \int \frac{d\eta}{1 - \eta^t} + C$$

I. I. Levi

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

259. Didkovskii, M. M., and Rodionov, I. A., The coefficient of roughness of earthen canals of large cross section (in Russian), *Izv. in-ta gidrol. i gidrotekhn. Akad. Nauk USSR* **12**, 28–45, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 501.

On the basis of the analysis of formulas for the velocity factor C and checking them with the experimental data on the resistance to the water movement in canals of large cross section and not carrying sediment, authors make the following deductions: (1) N. N. Pavlovsk's formula, substantiated by experimental data and widely accepted in practice in hydraulic calculations, must still be accepted as basic for determining the velocity of C. (2) The formula of I. I. Agroskin and the shortened one of Gangil'e-Kutter give satisfactory results in calculations for earthen canals, differing from the value of C by Pavlovsk's formula by up to 5%. (3) The value of the velocity multiplicand C, determined by means of the full Gangil'e-Kutter formula, differs from that calculated by the formula of Pavlovsk by 15 ÷ 35%.

Utilizing the results of the investigations of the Institute of Hydrology and Hydrotechnics of the Akad. Nauk SSSR, the Institute of Installations of the Akad. Nauk UzSSR, and of L. S. Kuskov and I. N. Dyment on the Moscow canal, authors have evolved and recommended a new scale for the roughness coefficient of earthen canals of large cross section, when the surface of wet perimeter is strengthened by lining up to 20% and when in calculations for C the Pavlovsk formula is used. In the article the generalized full formula of Gangil'e-Kutter is erroneously named as that of G. A. Dzhimsheli and, besides, the coefficient entering into it, 0.0155, is wrongly given as 0.155. G. A. Dzhimsheli

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

260. Altschul, A. D., The fundamental laws of the regular flow of water in channels (in Russian), *Izv. Akad. Nauk SSSR Otd. tekh. nauk* no. 5, 85–94, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3052.

The paper, which is devoted to the problem of obtaining, by theoretical means, solutions to problems of the velocity field and resistances, is founded on two propositions:

1. The tangent stress over the whole flow cross section is identical and equal to the greatest value at the bottom. This proposition was first introduced by Prandtl [*VDI Forschungsheft* **77**, no. 5, 1933] but in actual fact the tangent stress changes linearly along the vertical. It follows from the proposition, however, that the turbulent viscosity is equal to the product of the universal constant of the dynamic velocity and the distance from the bottom.

2. The tangent stress is equal to the product of the gradient of the velocity profile and the sum of the turbulent and physical (Newtonian) viscosities.

Boussinesq [*J. Math.* **2**, p. 13, 1868] demonstrated that, in turbulent flows, the first is hundreds of times greater than the physical viscosity, for which reason the latter is usually neglected in all analyses.

In the present paper, however, the physical viscosity has been retained in the starting equation. Consequently the solutions obtained for the velocity and resistance profiles have, compared with the solutions of other authors, additional terms depending on the viscosity and the maximum tangent stress. This explains the appearance in the formula for the resistances of a term depending on the viscosity and the gradient.

The whole trend of the paper underlines the indubitable, but rarely occurring in the literature, proposition that the problem of resistances cannot be treated separately from the velocity field.

The transition from the two-dimensional problem to channels is performed on the basis of the generally-known and ancient (1771) postulate—most inaccurate, as has been disclosed of recent years—of the dynamic identity of a flow of any form with a two-dimensional flow of the same area with a width equal to the wetted perimeter of the effective cross section.

V. N. Goncharov

Courtesy of Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

261. Klameth, E., The method of Bakhmeteff and its application to the hydraulic calculation of open supply canals (in German), *Wasserwirtschaft, Wien* **48,** 4, 90–97, Jan. 1958.

262. Radoslawoff, T., Flood discharge through a meandering short-cut (in Hungarian), *Hidrológiai Közlöny* **37,** 1, 24–25, Jan.-Mar. 1957.

Incompressible Flow

(See also Revs. 260, 315, 322, 392, 411, 447, 450, 470, 472, 473, 474, 475, 514, 529)

263. Hashimoto, H., On the flow of a viscous fluid past a thin screen at small Reynolds numbers, *J. Phys. Soc. Japan* **13,** 6, 633–639, June 1958.

The slow viscous flow normal to a perforated infinite plate is investigated using the Stokes approximation to the equations of motion. The main result of interest is that the ratio of the total flow flux to the pressure drop is proportional to the virtual mass of disks (or strips),-of cross sections congruent with the perforations, moving in a perfect fluid. An expression for the drag force on an elementary area of the plane is also given. The application to examples, including a single elliptical hole, and configurations of slits, illustrates the advantage of the results appearing in closed functional forms.

The study is complementary to that of Roscoe [AMR **3** (1950), Rev. 91]. E. E. Jones, England

264. MacKenzie, J. D., Viscous flow of liquids at constant volume and constant pressure, *J. chem. Phys.* **28,** 6, 1037–1039, June 1958.

The energy of activation for viscous flow at constant volume, E_v, is dependent on the volume of a liquid. For normal liquids at elevated temperatures, E_v is only a small fraction of the value of the activation energy at constant pressure, E_p. However, for associated liquids, because of the presence of hydrogen bonds, E_v is almost equivalent to E_p. It is suggested that in highly associated liquids like liquid silica and some molten glasses where flow necessitates the rupture of bonds of even greater energy, the difference between E_v and E_p should be negligible.

From author's summary

265. Miyagi, T., Viscous flow at low Reynolds numbers past an infinite row of equal circular cylinders, *J. Phys. Soc. Japan* **13,** 5, 493–496, May 1958.

Title problem, with flow normal to plane of cylinder axes, is investigated using Stokes's equations of motion as basis. Complex variable analysis determines the drag coefficient as an infinite series in the diameter-spacing ratio, and result agrees with that of Tamada and Fujikawa [AMR **11** (1958), Rev. 2678] deduced using Oseen's approximation for the flow at low Reynolds number. A numerical study is included, and a tentative formula for the drag coefficient is proposed when diameter-spacing ratio is near unity.

E. E. Jones, England

266. Takaisi, Y., The wall-effect upon the forces experienced by an elliptic cylinder in a viscous liquid, *J. Phys. Soc. Japan* **13,** 5, 496–506, May 1958.

Oseen's flow equations are used to determine the first approximations to the lift and drag coefficients for an elliptic cylinder moving uniformly at incidence to (1) a single plane boundary and (2) two parallel plane boundaries. The Reynolds number based on the major axis of the cylinder section as reference length is assumed small.

A considerable number of tables and graphs illustrate the variation of the coefficients with the geometrical and hydrodynamical parameters of the problem. It appears that the wall-effect on lift is greater than on drag, both increasing with decrease in the cylinder-wall separation distance. E. E. Jones, England

267. Kuwabara, S., The forces experienced by two elliptic cylinders in a uniform flow at small Reynolds numbers, *J. Phys. Soc. Japan* **13,** 5, 506–519, May 1958.

Imai's method [AMR **8** (1955), Rev. 2411] of solving Oseen's viscous flow equations is applied to determine the lift and drag coefficients for two parallel elliptic cylinders in a uniform stream. Approximate values for these coefficients are determined assuming that the distance between the cylinders is of the same order or greater than the reciprocal of the Reynolds number. Numerical results are recorded for symmetrically placed cylinders of cross sections ranging from the circle to the straight line segment.

E. E. Jones, England

268. Michael, D. H., The separation of a viscous liquid at a straight edge, *Mathematika* **5,** 1, 82–84, June 1958.

Based on the treatment of the steady motion of viscous liquid near a corner formed by two inclined planes, carried out by W. R. Dean and P. E. Montagnon [AMR **3** (1950), Rev. 1733], the separation of a plane steady flow of an incompressible viscous fluid at the edge of a rigid boundary is analyzed in linear approximation. It is shown that a true separation is only found for a free surface which, with steady derivative, continues the rigid boundary. Besides, there is still possible an adherent flow round the edge.

F. Engelmann, Germany

269. Ito, H., Friction factors for turbulent flow in curved pipes, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-14, 9 pp.

The object of this paper is to furnish the engineer with reliable data on the friction factors to be used in computing the pressure losses for turbulent flow in smooth curved pipes. The empirical formulas proposed, backed by theoretical considerations, appear to define the influence of curvature upon the law of resistance with satisfactory accuracy.

From author's summary

270. Dokolov, E. Ya., Some problems of the hydraulic analysis of heating circuits (in Russian), *Trudi Mosk. energ. in-ta* no. 24, 106–116, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3045.

Problems are discussed of the relationship between the coefficient of friction in pipelines and the nature of their surface roughness, as well as of the selection of the equations for the hydraulic calculation of heating networks. The expressions developed by A. Nikuradse, B. L. Schiffrinson, G. A. Murin, F. A. Shevelev and G. K. Filonenko are examined and recommendations are made concerning their applicability.

Yu. M. Savvin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

271. Yablonskii, V. S., More about the optimum conditions for the pumping of petroleum products in pipe systems (in Russian), *Neft. kh-vo* no. 5, 53–59, 1956; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1887. *Courtesy Referativnyi Zhurnal, USSR*
Translation, courtesy Ministry of Supply, England

272. Bukacek, R. F., Flow equations for natural gas pipelines, *Proc. Amer. Soc. civ. Engrs.* **84,** PL 2 (*J. Pipeline Div.*), Pap. 1667, 10 pp., June 1958.

273. Khovansky, G. S., A nomogram for calculating pipelines for laminar and turbulent flow conditions (in Russian), *Neft. kh-vo* no. 6, 53–56, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3044.

274. Haskind, M. D., Three-dimensional flow about thin bodies (in Russian), *Prikl. Mat. Mekh.* **20,** 203–210, 1956.

Potential theory methods are used to formulate a singular integro-differential equation for a in a cambered lifting line in a plane in a three-dimensional flow of an unlimited weightless fluid. Using methods of linear wave theory, equation is generalized to case of slender-body motion in fluid with weight. Plane in which cambered lifting line being considered lies is perpendicular to flow plane. Dorodnitsyn [*Prikl. Mat. Mekh.* **8,** 33–64, 1944] considered another case of a cambered lifting line in the flow plane.

Use of potential-theoretic methods permits an equation to be obtained for the cambered lifting line; hence, assumptions are explained to which the derivation of this equation is related. Solutions are given for this equation for a lifting line in the shape of half a ring for small and large Froude numbers. Also given is an approximate solution taking Froude number into account for a vertical rectilinear lifting line completely submerged in a heavy fluid.

Using these methods, Kūssner [*Luftfahrtforschung* **17,** 370–378, 1940] established the generalized Prandtl integro-differential equation for a rectilinear lifting line in the unsteady flow case.

From author's summary by M. D. Friedman, USA
Courtesy of Mathematical Reviews

275. Konokotin, V. V., The calculation of lateral apertures in air ducts of rectangular cross section (in Russian), 13-ya nauch. konferentsiya Leningr. inzh.-stroit. in-ta, Leningrad, 1955, 119–121; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2883.

Two tables are given of the values of the coefficients of local resistance "in through flow" for the cases of mixing and division of the currents, for an air duct of rectangular cross section with lateral apertures on the narrow side.

The coefficients of local resistance are presented in the form of the ratio of the air flow volumes before and behind the lateral opening, for two values of the ratio of the total to the dynamic pressure and for three ratios between the sides of the cross section of the air duct.

I. A. Shepelev
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

276. Peterson, D. F., Some results of experiments on the investigation of circulation in high-pressure steam boilers (in Russian), "Hydrodynamics and heat exchange in high-pressure steam boilers," Moscow, Akad. Nauk SSSR, 1955, 67–88; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2895.

Results are presented of an investigation into the circulation in high-power steam boilers with pressures up to 110 kg/cm², working with Moscow Basin powdered coal fuel. The tests were made in the laboratory of the Central Boiler and Turbine Institute between 1947 and 1951. The object of these investigations was to study the peculiarities of the circulation in high-pressure boilers and verify the influence of grinder-stokers on the conditions of circulation in such boilers.

Yu. A. Lashkov
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

277. Wallick, G. C., A note on transient two-phase flow calculations, *J. Petr. Technol.* **9,** 10, 47–49, Oct. 1957.

278. Kazantsev, E. I., An investigation of a free, submerged jet (in Russian), *Nauch. tr. Dnepropetrovsk. metallurg. in-ta* no. 31, 33–52, 1954; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3248.

Results are given of experimental investigations on a free jet of air issuing into a submerged space from a nozzle of 20.5-mm diameter. The results obtained are compared with the analytical and experimental results of other authors. Empirical formulas are suggested for calculating the velocity profile and axial velocity.

From the experimental results obtained, author draws conclusions concerning the decrease in quantity of motion along the jet which contradict all known experimental data on free jets [G. N. Abramovich: "Turbulent free jets of liquids and gases," Gosenergoizdat, 1948].

M. V. Krasnoglyadova
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

279. McArdle, J. G., Internal characteristics and performance of an aerodynamically controlled, variable-discharge convergent nozzle, *NACA TN* 4312, 14 pp. + 2 tables + 14 figs., July 1958.

The effective flow area of a convergent exhaust nozzle was reduced as much as 67% by injecting a secondary jet into the nozzle near the exit. Analytical expressions relating the performance with significant operating and design variables were developed, and experimental coefficients were evaluated. Some configurations were operated as jet deflectors.

From author's summary

280. Shul'gin, D. F., Unsteady motion of a thin permeable profile in a liquid (in Russian), *Trudi Sredneaz. in-ta,* no 66, 61–67, 1956; *Ref. Zh. Mekh.* no. 4, 1957, Rev. 4015.

Paper examines the unsteady motion of a slightly warped permeable profile. The pressure variation on passage through the porous surface is chosen in the form

$$\Delta p = a\nu + \lambda$$

where a and λ are the experimentally obtained constants characterizing the permeability of the profile, and ν is the penetration velocity.

In solving the problem, author uses L. I. Sedov's method ["Two-dimensional problems of hydrodynamics and aerodynamics;" Moscow-Leningrad, Gostekhizdat, 1950, 46–80]. Author reduces the solution of the problem to two integral equations of the first type. An accurate solution of this system was found for harmonic oscillations of the profile about the steady forward motion with constant velocity.

P. F. Korotkov
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

281. Dyban, E. P., and Shvetz, I. T., The problem of hydraulic resistance and heat exchange in capillary ducts (in Ukrainian), *Dopovidi Akad. Nauk URSR* no. 1, 50–53, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3165.

Results are presented of an experimental investigation in the hydrodynamic resistance and heat exchange in the motion of an incompressible fluid (air—Mach 0.15) along capillary ducts. It is found that the usual quantitative relationships characterizing the hydraulic resistance and process of heat exchange retain their force.

A. A. Gukhman
Courtesy of Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

282. Leg[illegible], Elliptic functions and integrals with real modulus in fluid mechanics, *NACA TN* 1435, 96 pp. + 63 fig., June 1958.

Translation of "Les fonctions et Integrales Elliptiques a Module Reel en Mecanique des Fluides." *ONERA Pub.* no. 71, 1954.

Ed.

Compressible Flow (Continuum and Noncontinuum Flow)

(See also Revs. 246, 312, 313, 326, 360, 364, 366, 374, 375, 390, 393, 394, 419, 458, 467, 478, 480, 482, 492, 504)

283. Horlock, J. H., The compressible flow through cascade actuator discs, *Aero. Quart.* **9,** 2, 110–130, May 1958.

Cascade actuator disk theory for incompressible flow is summarized. Following assumptions of Ruden, author determines approximate equations for axial perturbation velocitites. For both two- and three-dimensional flow these give an exponential decay up to and away from the rotor. Results are compatible with experimental evidence. Theory is extended first to the direct (flow far upstream and distribution of outlet angle from cascade known) and indirect problems (axial velocities far upstream and downstream known) and secondly to subsonic compressible flow.

Reviewer notes that an alternative statement of author's Eq. [16] is:

$$\mu_{01}\, r^{\beta} = \text{constant}; \quad \beta = \tan^2 \alpha_{02}/2 + \tan^2 \alpha_{03},$$

$$\text{with } \mu_{01} = \mu_{02} = (\mu_1 + \mu_2)/2.$$

In some cases this may be more useful than the result given.

Author's analysis of compressible flow is a worthwhile extension of actuator disk theory. For subsonic flow it is shown that decay of axial velocity should be slightly less than for a corresponding incompressible flow. Density ratio across disk is shown to be appreciable. L. C. Woods, Australia

284. Gustafson, W. A., and Krzywoblocki, M. Z. v., On multiplicity theorems and an exact solution in diabatic flow. I, II, *Acta Phys. Austr.* **11,** 2, 131–146, 1957; **11,** 3, 294–320, 1957.

The substitution principle of Munk-Prim is used to derive multiplicity theorems and an exact solution to the Hicks-Guenther-Wasserman canonical equations for ideal diabatic flow in a compressible nonviscous gas. No physical or engineering applications are given. G. Birkhoff, USA

285. Lidov, M. L., The theory of linearized solutions in the unidimensional simulation of gas motion (in Russian), *Doklady Akad. Nauk SSSR (N.S.)* **102,** 6, 1089–1092, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2729.

The algebraic integral of a nondimensional system of equations in variants is set up, obtained in the analysis of motions differing little from the unidimensional, adiabatic, simulated motions of an ideal gas.

The adiabatic character of the motion is a substantial feature of the analysis. V. P. Karlikov

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Translation, courtesy Ministry of Supply, England

286. Zhukovsky, M. I., The construction of profile grids from a given velocity distribution in a subsonic flow (in Russian), *Energomashinostroyeinie* **5,** 14–18, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2906.

The method of construction of a two-dimensional cascade in a potential flow of an incompressible fluid, previously published by author, is extended to the subsonic flow of a gas in the approximate conditions stated by S. A. Chaplygin. As an example of the application of the method, a cascade of the compressor type is considered. The method of satisfying the condition of continuity of the profile is not indicated.

The method described differs only in immaterial details from that already developed by the present reviewer. Referring to the work of L. I. Sedov, dating from the year 1947, author restricts its results to the solution of the problem of the flow of the gas around the profile. G. Yu. Stepanov

Courtesy of Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Book—287. Bers, L., Mathematical aspects of subsonic and transonic gas dynamics. New York, John Wiley and Sons, Inc. (Surveys in Applied Mathematics, Vol. 3), 1958, xv + 164 pp. $7.75.

This report on subsonic and transonic gas flow theory is written from the point of view of a mathematician. It is concerned with a limited part of the theory of compressible fluid flow—two-dimensional steady potential flows. Mathematical methods are emphasized rather than the physical problems themselves, and the "applications" of fluid dynamics as a source of mathematical concepts are stressed. Particular attention is paid to existence and uniqueness questions for subsonic and transonic flow problem.

This monograph, published as part of a five-volume series, was prepared under the editorial direction of Applied Mechanics Reviews. Preparation of the material was under the sponsorship of the Office of Naval Research, U. S. Navy. Ed.

288. Hunton, L. W., Effects of fixing transition on the transonic aerodynamic characteristics of a wing-body configuration at Reynolds numbers from 2.4 to 12 million, *NACA TN* 4279, 11 pp. + 19 figs., July 1958.

A wing-body combination having a plane tapered wing of aspect ratio 3 and 3-percent-thick biconvex sections was tested. Lift, drag, and pitching-moment results are shown for Mach numbers from 0.7 to 1.3 and Reynolds numbers from 2.4 to 12 million. The large effects of Reynolds number found for the model were practically eliminated when transition was fixed with a single element wire on both the body and the wings.

From author's summary

289. McDevitt, J. B., and Taylor, R. A., Pressure distributions at transonic speeds for slender bodies having various axial locations of maximum diameter, *NACA TN* 4280, 9 pp. + 22 figs., July 1958.

The measured static-pressure distributions at the model surface and in the surrounding flow field are presented for a related series of five bodies of revolution having various axial locations of maximum cross-sectional area. The bodies were tested at zero angle of attack through a Mach number range from 0.80 to 1.20.

From authors' summary

290. Page, W. A., Experimental study of the equivalence of transonic flow about slender cone-cylinders of circular and elliptic cross section, *NACA TN* 4233, 20 pp. + 1 table + 12 figs., Apr. 1958.

Pressure coefficients for elliptical cone-cylinder wing of aspect ratio 2, thickness ratio 6%, are compared with those for equivalent circular cone cylinder of 7° half-angle for $0.6 < M < 1.4$ and angle of attack $\alpha = 0°$ to 8°. Author concludes that, in steady flow, coefficients for any slender body at small α and $M \approx 1$ can be deduced from theory if pressures on equivalent body of revolution are known. He speculates that range of validity is same as for area-rule. W. Griffith, USA

291. Morawetz, Cathleen S., On the non-existence of continuous transonic flows past profiles. III, *Comm. pure appl. Math.* **11,** 1, 129–144, Feb. 1958.

Consider a manifold of almost identical pressure density relationships. For each relationship there exists a set of smooth transonic flows, each corresponding to a different profile but all having the same speed at infinity. In, at most, one of these flows a small change in the speed at infinity does not result in the appearance of a shock wave.

A. R. Mitchell, Scotland

292. Kusukawa, K., On the transonic flow of a compressible fluid past an axisymmetric slender body at zero incidence, *J. Phys. Soc. Japan* **12,** 401–410, 1957.

After being subjected to an affine transformation and the neglect of one term, the differential equation for the stream function of axisymmetric transonic small-perturbation flow is formally the same as that for plane transonic flow. The boundary conditions, however, are not the same. Here the respective transonic similarity laws for plane and axisymmetric flow are drawn upon to obtain an approximate relation between the velocities at the surfaces of the obstacles. An example is presented in which the results for a finite wedge at sonic speed, obtained by Guderley and Yoshira [*J. Aero. Sci.* **17,** 723–735, 1950; AMR **5** (1951), Rev. 3299], are used to obtain the pressure distribution for a paraboloid of revolution. An attempt is also made to relate the head drag coefficient given by the present theory to that obtained by Miles [ibid. **23,** 146–154, 1956; AMR **9** (1956), Rev. 2587] and it is concluded that the Miles's formula probably fails for blunt obstacles.

W. R. Sears, USA

293. Kryuchin, A. F., The theorem of the singularity of the solution of the problem of a flow around a wedge-shaped profile of gas with an approximately sonic velocity (in Russian), *Prikl. Mat. Mekh.* **19,** 5, 639–640, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2761.

A proof is given of the singularity of the solution of the boundary problem investigated by the author, repeating without material divergence the already known proof of F. I. Frankl [*Izv. Akad. Nauk SSSR, Ser. Mat.* no. 2, 1945].

L. V. Ovsyannikov

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294. Page, R. H., A note on sonic sudden enlargements, *Jet Propulsion* **28,** 4, 256–257, Apr. 1958.

295. Czarnecki, K. R., Sevier, J. R., Jr., and Carmel, M. M., Effects of fabrication-type roughness on turbulent skin friction at supersonic speeds, *NACA TN* 4299, 9 pp. + 10 figs., July 1958.

The results of this investigation indicate that the effects of both Reynolds number and Mach number can be correlated on the basis of changes in flow characteristics within the inner parts of the boundary layer. Consequently, increasing the unit Reynolds number has a detrimental effect and increasing Mach number has a powerful alleviating effect on drag due to surface roughness. The correlation of the effects of changes in roughness height or shape awaits a more comprehensive analysis than was attempted in this paper. Further investigation must be made of the effects of roughness sweep and possibly mutual interference effects.

From authors' summary

296. Wang, C. J., and Peterson, J. B., Spreading of supersonic jets from axially symmetric nozzles, *Jet Propulsion* **28,** 5, 321–328, May 1958.

Authors use standard formulation of method of characteristics to solve problem on high-speed computer. Flow is found for both conical and parallel flow nozzles exiting into still and moving air. Several exit Mach numbers and ratios of specific heats are considered. Principal results show that increase in divergence of nozzle exit or increase in exit pressure increases jet divergence; increase in exit Mach number or external stream Mach number decreases jet divergence; and increase in ratio of specific heats decreases jet divergence. In addition, authors indicate that changes in external flow have little effect on flow in center of jet.

R. C. Roberts, USA

297. Evans, Martha W., and Harlow, F. H., Calculation of supersonic flow past an axially symmetric cylinder, *J. aero. Sci.* **25,** 4, 269–270 (Readers' Forum), Apr. 1958.

298. Vereschchagin, L. F., Semerchan, A. A., Filler, F. M., and Galaktionov, V. A., Effect of the reservoir on the flow of a stream of water at supersonic speed, *Sov. Phys.-Tech. Phys.* **2,** 11, 2451–2456, Nov. 1957 [Translated from *Zh. Tekh. Fiz., Akad. Nauk SSSR* **27,** 11, 2640–2646 by Amer. Inst. Phys., N. Y.]

Ultrasonic speeds of water may be caused by a hydraulic compressor at ultra high pressures. Paper deals with the degree of dampening of the pressure pulses resulting from operation of piston, when certain reservoir volume is available between the compressor and the exit nozzle. Compressibility of water smooths out flow produced by alternating movement. Authors used continuity equation, assuming linear relationship between pressure and volume incrementals. Following assumptions were introduced: 1) Constant velocity in the nozzle, and derived from Bernoulli's equation; 2) piston speed taken as constant and equal to the average; 3) constant coefficient of compressibility. Following theoretical conclusions are obtained: Pressure fluctuations increase with output and vary inversely to the reservoir volume; and to average pressure experiments were made with piston diameter of 38 mm and volumes of 1, 3.3, 4 and 5.85 liters, using pressures from several hundreds up to 2500–3000 atmospheres. An electric piezometer and an electronic circuit enabled graphical observations of pressure fluctuations. Agreement between experimental observations and theoretical conclusions was fairly good, with the exception that in certain cases, for a constant volume of reservoir, the ratio of minimum to maximum pressure increased up to a certain pressure and then decreased, which showed that after that point fluctuations started to increase.

A. Balloffet, USA

299. Beane, B. J., Note on swept wing planforms which correspond to the same two-dimensional potential problem for finding minimum drag as the elliptical planform, *Douglas Aircr. Co. Rep.* SM-22986, 11 pp., Nov. 1957.

In linearized supersonic flow let the curve of intersection of the two envelopes of Mach waves caused by a wing in forward and reversed flow be called the Mach rim. Attempt to determine the wing of minimum drag for fixed total lift. Although this problem is solved by elliptical wings, the solution is non-unique. E. W. Graham [AMR **10** (1957), Rev. 3392] has shown that other solutions are defined by the following problem for a two-dimensional potential ϕ in a plane normal to the direction of flow: (1) ϕ prescribed on the normal projection of the Mach rim onto this plane; (2) normal derivative $\partial\phi/\partial n$ prescribed on the normal projection of the wing. Without changing these projections, and thus not changing the potential problem, author modifies the elliptic wing's Mach rim so that its new projection onto the plane of the wing now consists of two symmetrical straight line segments joined by a hyperbolic arc. Corresponding planforms have sharp vertices, sweptback leading edges, and sometimes smaller area than original elliptic wing. Author presents computed planforms and graphs of $C_D/\beta C_L^2$ versus $2\beta S/C$, where $\beta^2 = M^2 - 1$, $2S$ is span, C midchord.

J. H. Giese, USA

300. Carriere, P., Theoretical methods for the study of supersonic flows (in French), *Publ. sci. tech. Min. Air, France,* no. 339, 234 pp., 1957.

Author is interested in exact methods for treating steady inviscid supersonic flows and text is devoted mainly to method of characteristics. Chapter I is conventional exposition of steady one-dimensional flow and shock waves. Chapter II deals with plane flows mainly from hodograph point of view. Chapter III gives general treatment of characteristics with applications to plane flows, while in Chapter IV, together with conical flow theory, applications are to axisymmetric flows.

Of value are numerous worked examples and tables but reviewer notes that, throughout, computations are made with $\gamma = 1.405$ rather than $\gamma = 1.40$.

H. C. Levey, Australia

301. Rosner, D. E., Wall temperature instability for convective heating with surface radical recombination, *Jet Propulsion* **28,** 6, 402–403 (Tech. Notes), June 1958.

The above titled problem is analyzed for the stagnation region in hypersonic flight with a chemically frozen boundary layer. The total rate of heat transfer q is set to depend only on molecular conduction q_c, diffusion q_D, and the catalytic properties of the wall. With increasing wall temperatures T_w, q_c decreases, whereas q_D may rise appreciably with rising catalytic reaction rates at the wall. Consequently, a plot of q vs T_w may exhibit a minimum followed by a maximum. By plotting the heat-transfer capacity of the coolant (say Q) vs T_w one may get a set of monotonically increasing curves for different rates of coolant flow. The temperature interval for which the slope of Q is smaller than the slope of q (at the same T_w) is a region of instability; such stable wall temperatures cannot be reached. A hysteresis loop is indicated lying between the two curves for which Q has the same slope with q. The similarity to the quasi-steady thermal ignition and extinction of combustion occurring at solid surfaces is shown. Paper is only qualitative. Reviewer feels that described behavior for model chosen is plausible. Only quantitative results will show practical significance. P. S. Lykoudis, USA

302. Lees, L., Recent developments in hypersonic flow, *Jet Propulsion* **27,** 11, 1162–1178, Nov. 1957.

Some of the advances in the understanding of hypersonic flow phenomena made in the past two years since author gave his great survey on this complex topic [AMR **10** (1957), Rev. 2601] are reviewed. In contrast to the convective heat-transfer problem, which in the meantime turned out to be simpler than originally supposed, the analysis of the inviscid flow in the nose region of a blunt body really seems to be a more subtle question. This is a consequence of the fact that the flow behind the shock wave round such a body is essentially transonic and that the shape of the body in the sonic region has an important influence on the character of the flow. Freeman's [AMR **10** (1957), Rev. 3704], Chester's [AMR **10** (1957), Rev. 3696], Maslen and Moeckel's [AMR **11** (1958), Rev. 2222], Li and Geiger's [AMR **10** (1957), Rev. 2979], Hayes', Garabedian's, Heybey's and Probstein's work on inviscid hypersonic flow in nose region of blunt bodies with nearly spherical and with nearly flat noses is reviewed, and very interesting experimental studies of the effect of nose shape at $M = 5.8$ made by Fraasa and Wisenbaker at GALCIT (schlieren photographs of the bow waves and some pressure distributions) are discussed.

There is a section on inviscid hypersonic flow over blunt-nosed slender bodies with recent applications and extensions of the blast wave analogy (with special reference to the search for Taylorian flow similarity), reviewing the work in this field of the author and Kubota [AMR **11** (1958), Rev. 3706], Munson and others, especially on power bodies (plane and axisymmetric), both from the theoretical and experimental point of view. Viscous effects in hypersonic flow are the object of the last section, which reviews work of author [AMR **9** (1956), Rev. 3766], Hammit and Bogdonoff [AMR **9** (1956), Rev. 3290], Yasuhara [AMR **10,**(1957), Rev. 799], Hayes [AMR **9** (1956), Rev. 3074], Probstein and Elliott [AMR **9** (1956), Rev. 2621], Schaaf and Sherman, Laufer and McClellan [AMR **10** (1957), Rev. 3772], and many others.

Discussion of the power body and the hemisphere cylinder shows that the problem of the emergence of the boundary layer from the low Mach number region behind the strong part of the bow shock, and the effects of transverse curvature on the viscous layer in the presence of (partially self-induced) axial pressure gradients have become problems of growing importance. Finally, some aspects of low Reynolds number flow and molecular effects at hypersonic speeds are given in an excellent survey.

H. Behrbohm, Sweden

303. Allen, H. J., Hypersonic flight problems (introductory remarks), *Jet Propulsion* **27,** 11, p. 1145, Nov. 1957.

As topics which must be investigated for the development of successful rocket craft are cited: physics of the upper atmosphere, aerodynamic heating of the craft's outer surface and questions of critical thermal stresses and temperature-stress history in its interior, analysis of the transonic type of flow imbedded in a hypersonic field and developing round blunt noses, together with related questions of imperfect gas effects in the subsonic regime, wind-tunnel and flight experiments to collect such information, and their technical difficulties. H. Behrbohm, Sweden

304. Niblett, B., and Blackman, V. H., An approximate measurement of the ionization time behind shock waves in air, *J. Fluid Mech.* **4,** 2, 191–194, June 1958.

A hydromagnetic shock tube was used to obtain an approximate measurement of the time to reach equilibrium ionization behind shock waves of Mach number 11 to 17, moving into air at a pressure of about 1 mm of mercury. This ionization time decreases with increasing Mach number. Experimental results are presented as a graph of the ionization time versus Mach number. The principal source of error in the measurements is the attenuation of the shock, and the results indicate a lower limit for the ionization time in air. From authors' summary

305. Martin, B. W., and Bayley, F. J., The effect of shock waves on the isentropic efficiency of convergent-divergent nozzles, *J. roy. aero. Soc.* **62,** 569, 377–382 (Tech. notes), May 1958.

306. Marshak, R. E., Effect of radiation on shock wave behaviour, *Physics of Fluids,* **1,** 1, 24–29, Jan.–Feb. 1958.

The fundamental conservation equations governing fluid dynamics and including radiation are written down. The Rankine-Hugoniot conditions are derived for shock waves subjected to radiation flux. Similarity solutions are obtained for the constant density and constant pressure cases. Some results are stated for the combined radiation-fluid dynamics corresponding to a power law dependence of the temperature on the time.

From author's summary by M. Bader, USA

307. Gross, E. P., and Ziering, S., Kinetic theory of linear shear flow, *Physics of Fluids* **1,** 3, 215–224, May–June 1958.

Isothermal Couette flow of a monatomic gas in which dissipation may be neglected is studied in consideration of equilibrium distribution deviations based on the linearized Boltzmann equation. The wall condition requiring a fraction of specularly reflected molecules and the balance emitted with a Maxwellian distribution is retained. Explicit results are given for the distribution function, flow velocity and stress for a general law of force. Numerical results are presented for hard sphere molecules. Results are shown for both the high pressure and low pressure region and the slip flow region. The effects of the nonuniform distribution near the wall in the slip flow region are completely negligible at distances greater than one-eighth of a mean-free-path-length from the plate.

R. M. Drake, Jr., USA

308. Baker, R. M. L. Jr., and Charwat, A. F., Transitional correction to the drag of a sphere in free molecule flow, *Physics of Fluids* **1,** 2, 73–81, Mar.–Apr. 1958.

The mechanics of collisions between molecules in front of a sphere moving at hypervelocity through a rarefied atmosphere are analyzed. The study is concerned with the "transitional" regime in which molecules emitted by the surface begin to shield the body from the oncoming Newtonian stream, and the net drag decreases from its free-molecular value. It is found that a simplified but physically significant model can be formulated, and that it leads to a dependence of the drag coefficient on two transition parameters. These can be interpreted as the Reynolds number and the surface-to-free-stream temperature ratio. The predictions of this

theory agree qualitatively and in order of magnitude with observations.

From authors' summary by R. E. Street, USA

309. Patterson, G. N., Molecular approach to problems of high-altitude, high-speed flight, *Univ. Toronto Inst. Aerophys. Rep.* 10, 36 pp. + 61 ref. + 21 figs., May 1957.

The paper summarizes some research and problems on high-speed flight at extreme altitudes. Zones of the upper atmosphere, regimes of fluid mechanics, and experimental methods for investigating these regimes are discussed. Rarefaction effects are discussed in terms of gas-surface interactions, free molecule flow, and slip flow. Newtonian flow is considered as an extension of free molecule motion. Effects of high temperature are indicated for undissociated air and air in dissociation equilibrium. Important effects of relaxation are outlined.

From author's summary by C. C. Taylor and C. F. Hansen, USA

310. Laitone, E. V., and Stout, J. E., Mach reflections in two-dimensional diffusers from hydraulic analogy experiments, *Jet Propulsion* **28,** 4, 257–259, Apr. 1958.

The separation distance required to prevent the formation of a Mach reflection between two wedges, representing either a two-dimensional diffuser or a Busemann biplane, is obtained by assuming that the normal shock wave could not have been created if the first expansion wave from the shoulder of the wedge would intersect it. This hypothesis is verified experimentally for the special case corresponding to a specific heat ratio of $\gamma = 2$ by means of the shallow water hydraulic analogy.

From authors' summary

311. Korobeynikov, V. P., The integrals of the equations of unsteady, adiabatic motions of a gas (in Russian), *Doklady Akad. Nauk SSSR (N.S.)* **104,** 4, 509–512, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2730.

A generalization is made of the adiabatic integral for simulated motions, as found by M. L. Lidov [*Doklady Akad. Nauk SSSR* **103,** no. 1, 1955] for the case of the nonsimulated motion of a gas corresponding to any state equation but on the assumption that the nondimensional characteristics of the motion are resolved into series according to a particular, time-dependent variable.

V. P. Karlikov

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Translation, courtesy Ministry of Supply, England

Boundary Layer

(See also Revs. 273, 280, 288, 295, 301, 307, 369, 390, 394)

312. Culick, F. E. C., and Hill, J. A. F., A turbulent analog of the Stewartson-Illingworth transformation, *J. aero. Sci.* **25,** 4, 259–262, Apr. 1958.

Modified Stewartson-Illingworth transformation applied to turbulent compressible adiabatic boundary layer in gas of Prandtl number equal to unity. Viscosity, which need not be linear in temperature, is evaluated at reference temperature determined empirically. Method is combined with that of Truckenbrodt for growth of momentum thickness to predict boundary layer on supersonic wind-tunnel nozzle. Good agreement with experiment is reported. D. B. Spalding, England

313. Jack, J. R., Effect of favorable pressure gradients on transition for several bodies of revolution at Mach 3.12, *NACA TN* 4313, 12 pp. + 8 figs., July 1958.

Transition locations on two constant-pressure-gradient models and two power-profile models ($r \propto x^n$) were compared with those from a conventional cone. A constant pressure gradient $[d(p/p_o)/dx]$ of -0.10 per inch increased the distance to transition by a factor of 1.58 times that for a cone, whereas the combined effect of blunting and a favorable pressure gradient increased the distance to transition by a factor of 2.7 times that obtained for a cone. In each case the transition Reynolds number based on local conditions was independent of unit Reynolds number.

From author's summary

314. Kuethe, A. M., On the character of the instability of the laminar boundary layer near the nose of a blunt body, *J. Aero. Sci.* **25,** 5, 338–339 (Readers' Forum), May 1958.

315. Curle, N., Hydrodynamic stability of laminar wakes, *Physics of Fluids* **1,** 2, 159–160, Mar.–Apr. 1958.

316. Donnelly, R. J., and Hallett, A. C. H., Periodic boundary layer experiments in liquid helium, *Ann. Phys., Leipzig* **4,** 3, 320–345, Mar. 1958.

Paper discusses experiments conducted with bodies of various forms oscillating in liquid He. By studying the change in damping characteristics with amplitude, insight is given to the hydrodynamics of liquid helium (a two-phase problem involving the normal and superfluid components). A simple mathematic model is set up for the oscillating boundary layer.

Experimental results from oscillating disks, a stack of disks, an oscillating sphere, the pendulation of the liquid in a U tube, and the transient motion of the surface of a beaker of liquid helium suddenly set into rotation are collated to establish critical amplitudes, corresponding Reynolds numbers, and values of the kinematic viscosity. Values of R_{crit} for the onset of turbulence are discussed, and several forms, including an empirical one (which remains constant with temperature), are outlined.

A number of most interesting problems, particularly to hydrodynamicists, arise because of the unique properties of the normal/superfluid combination and the uncertainty of superfluid behavior.

R. Culver, Australia

317. Williams, F. A., The conservation equations for multicomponent gas mixtures in arbitrary coordinate systems *J. aero. Sci.* **25,** 5, 343–344 (Readers' Forum), May 1958.

The conservation equations for multicomponent reacting gas mixtures are generally given only in Cartesian or orthogonal curvilinear coordinate systems. Actually, the conservation equations are easily expressed in an arbitrary coordinate system. Author presents the general equations in tensor notation and then indicates the simplifications which arise for orthogonal curvilinear coordinates. From author's summary

318. Şigalla, A., Experimental data on turbulent wall jets, *Aircr. Engng.* **30,** 351, 131–133, May 1958.

Paper is an attempt to correlate most of the available experimental data on the wall jet so that it is readily available for design purposes. The method of correlation closely follows the presentation given by Squire for the experimental data on free jets.

From author's summary

Turbulence

(See also Revs. 312, 316, 318, 469, 549, 576)

319. Wentzel, D. G., On the spectrum of turbulence, *Physics of Fluids* **1,** 3, 213–214, May–June 1958.

Author works out a specific example of the spectrum of turbulence in the region where the Kolmogoroff principle is likely to hold. The decay of turbulence with time is computed, and approximate formulas are presented. L. Trilling, USA

320. Chuang, F., On the decay of turbulence, *Acta Sci. Sinica* **2,** 187–200, 1953.

Paper considers the decay of isotropic turbulence by assuming (a) similarity of all aspects of the motion not directly involved in

viscous dissipation of energy and (b) that this part of the motion is specified uniquely by the rate of energy dissipation per unit mass and by its time derivative. Using Loitsiansky's invariant relation, a decay law is deduced in which the energy decays asymptotically at the $-10/7$ power of the time. In the second part of the paper, a similar analysis is applied to the approach to the final period of decay and it is shown that, to a first approximation, turbulent transfer between Fourier components of different wave numbers is equivalent to an added viscosity.

A. A. Townsend, England

Aerodynamics

(See also Revs. 1, 205, 265, 266, 267, 280, 290, 299, 355, 359, 361, 362, 363, 368, 477, 480, 481, 484, 487)

321. Carafoli, E., and Horovitz, Beatrice, Homogeneous supersonic flow of higher order around a cross-shaped wing (in French), 9th Congrès intern. Mecan. appl., Univ. Bruxelles, 1957; **2,** 104–117.

Paper generalizes earlier investigation of the authors [*Rev. Mécan. Appl.* **1,** 7–33, 1956] on conical flow (velocity potential homogeneous of order $n = 1$) round cruciform triangular wing configurations to the case of homogeneity of order $n > 1$. Theory of P. Germain [*Rech. aéro.* **7,** 1949] is used and investigation is confined to configuration lying wholly in the interior of the Mach cone through its vertex. Both the cases of symmetric incidence of wing and fin and the cases of antisymmetric incidence of wing and fin are considered, and an example is worked out for $n = 2$. Theory is, finally, applied to treat a cruciform triangular configuration oscillating harmonically with a reduced frequency that is sufficiently small to allow equation of "reduced potential" to be given by wave equation in three variables. This problem, being theoretically (as regards specifically *cruciform* configurations) of interest in the rolling case only, reduces to a homogeneous problem with $n = 2$.

H. Behrbohm, Sweden

322. Mangler, K. W., and Smith, J. H. B., Flow past slender delta wings with leading edge separation (in English), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **2,** 137–145.

An approximate theory is given for the steady flow over thin, highly swept delta wings with outflow at all edges, i.e., with flow separation along the sharp leading edges. Potential flow is assumed and slender wing theory is used. For the vortex sheet springing from the leading edge and rolling up to a vortex core the conditions are formulated that (a) the flow is parallel to the surface of the sheet and that (b) the pressure is continuous across it. The problem then is, from (a) and (b) and the tangency condition of flow on wing, to obtain shape and vorticity distribution of the sheet, and vorticity distribution on wing. This problem is approximately solved in the following manner: Using a well-known conformal transformation of the transverse plane (namely opening the horizontal rectilinear slit, described by the wing in the transverse plane, into a circle and closing it again in the perpendicular direction to a vertical slit) one gets rid of the tangency condition on the wing. In this transformed transverse plane the transformed vortex sheet is assumed to be a circular arc of radius R_1 and subtending an angle 2θ, springing from the origin (the leading edge of the physical plane), while the transformed vortex core is assumed to be a circle with radius R_2 and with its center on the terminal radius of the circular arc representing the sheet. The transformed vorticity distribution on the circular sheet is approximated by a trigonometric polynomial of the first degree (containing three parameters γ_1 γ_2, γ_3); the effect of the core on the outer field is represented by that of an isolated vortex located at the core center and with circulation Γ. For these three parameters R_1, R_2, θ, γ_1, γ_2, γ_3, Γ, seven equations are set up, some of them giving exact and some approximating or averaging formulations of physical conditions, such as (a) and (b), for instance, which necessarily must be fulfilled. These seven equations are then solved by trial and error.

Some numerical results are given and checked with experimental values. Compared with those of Brown and Michael [AMR **9** (1956), Rev. 229] they show a better agreement with experiments both with regard to integrated normal force and to vortex position over the wing.

H. Behrbohm, Sweden

323. Sheppard, L. M., A note on the wave drag of "exposed" rectangular wings *J. roy. aero. Soc.* **62,** 568, 306–307 (Tech. Notes), Apr. 1958.

Note gives a simple relationship between the zero-lift wave drag of the wing of a rectangular wing-and-body combination and the wave drag of the portion of the gross wing blanketed by the body, both evaluated as if isolated (i.e. ignoring the interference of other parts of the combination). The result is valid only when the tip Mach cones of the wing lie downstream of the blanketed wing. Detailed results are given for the case of wings with double-edge section, the maximum thickness being at mid-chord.

From author's summary

324. Poliakhov, N. N., Inductive forces in the unsteady motion of a wing profile (in Russian), *Vestnik Leningr. in-ta* no. 7, 87–93, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2771.

The unsteady motion of a profile is investigated, behind which a vortex tract located along a particular line is formed. With reference to a movable coordinate system attached to the profile, the potential of the flow velocity outside the profile is written as the sum:

$$\Phi = u_c\Phi_1(x, y) + v_c\Phi_2(x, y) + \omega\Phi_3(x, y) + \frac{\Gamma}{2\pi}\Phi_4(x, y) + \Phi_s(x, y, t)$$

where Φ_s is potential of the flow velocity produced by the wake vortices.

Applying the Lagrange integral, author determines the forces acting from the fluid side.

It is demonstrated that the formula for the hydrodynamic reaction forces contains an additional term of the form:

$$R_i = \int V_i X \gamma_n ds \qquad [8]$$

in which γ_n is density of the attached vortices of the profile, distributed along its contour $\overline{V}_i$, the velocity induced on the profile contour by the above attached profile vortices and the wake vortices. Integration is performed along the contour of the profile.

It is pointed out that Eq. [8] is analogous to the formula furnished by the theory of a wing of finite span for the induced drag forces.

G. G. Tumashev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

325. Minton, P., and Francis, J. R. D., The aerodynamic drag of perforated plates at zero incidence *J. roy. aero. Soc.* **62,** 568, 301–303 (Tech. notes), Apr. 1958.

326. Keune, F., Low-aspect-ratio wings with small thickness at zero lift in subsonic and supersonic flow (in German), *Dtsch. Versuchsanstalt Luftfahrt Rep.* 50, 68 pp., Apr. 1958.
[See AMR **6** (1953), Rev. 3508]

327. Sutherby, P. F., Possible flight paths for helicopters, *J. roy. aero. Soc.* **61,** 564, 811–814, Dec. 1957.

328. Summerlin, F. A., and Sullivan, N., The application of a block diagram representation to aircraft stability analysis, *Aero. Quart.* **9,** 1, 34–54, Feb. 1958.

The dynamic stability of a rigid airplane is analyzed by representing the motion in terms of a servomechanism or a feedback system. The method is illustrated by considering the lateral (asymmetric) motion of an airplane in which coupling between the longitudinal and lateral degrees of freedom is negligible.

The lateral equations of motion can be represented in block diagram form in the conventional manner of a servomechanism. This block diagram can be split into four parts, each of which can readily be given the proper physical interpretation. For example, a loop representing the motion of the airplane in pure roll, and another loop representing the air plane in yaw only are easily recognized in the block diagram. Each of the four parts of the block diagram are treated separately and the author shows how these relatively simple parts can be combined to give the lateral response of the whole airplane.

A generalized automatic control system is finally superimposed on the airplane's block diagram. The whole system can then be analyzed by conventional servomechanism methods.

The paper is well written and does much to point out some of the advantages of applying servomechanism methods to the dynamic stability analysis of the airplane.

E. K. Parks, USA

329. Wolkovitch, J., A method of optimising aircraft autostabilizer systems, *Coll. Aero. Cranfield Rep.* 113, 68 pp. + 2 tables + 32 figs., May 1957.

Procedure is outlined and illustrated wherein "optimum" stability augmentation of aircraft is obtained by minimizing required pilot effort in response to some specified disturbance. Procedure is analytical and is applied to linear systems and some special nonlinear systems. In opinion of reviewer this method of determining required stability augmentation offers no advantages over existing method. L. Becker, USA

330. Legostev, N. I., Some problems of the stability of irregular motions of a controllable aeroplane (in Russian), Avtorefer. diss. kand. fiz.-matem. nauk, Leningr. politekhn. in-ta, Leningrad, 1956; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 148.

331. Abzug, M. J., High-speed stability and control problems as they affect flight testing, *AGARD Rep.* 120, 26 pp. + 20 figs., May 1957.

Author discusses high-speed stability and control flight testing from the standpoints of the maximum envelopes of attainable Mach number and altitude, and load factor and Mach number. He also describes testing techniques which have been used for some special high-speed stability and control problems, and touches upon the flight testing of irreversible flight-control systems and automatic systems. Author concludes that reliance on analytical methods is essential to the success of such a flight-testing program. From author's summary

332. Prosnak, W., Theory of two-dimensional aerofoil with jet flap (in English), *Arch. Mech. stos.* **10,** 1, 3–24, 1958.

The problem of jet flap is treated from the theoretical point of view using the classical methods of conformal mapping.

Starting from the superposition of the known potential of the circular profile, and the potential of a source located in a suitable manner, and introducing judiciously chosen assumptions (of small width of the gap, location of the gap in the vicinity of the trailing edge and small profile camber), author obtains very simple equations for the load coefficients and the location of the aerodynamic center of load.

In the range of small intensities of the flowing jet, where the character of flow assumed and the simplifying assumptions are justified, good agreement with the results of experiments is obtained. W. Fiszdon, Poland

333. Bullen, N. I., Aircraft loads in continuous turbulence, *AGARD Rep.* 116, 8 pp. + 9 tables + 7 figs. + appendixes, Apr./May 1957.

Turbulence sufficient to activate a counting accelerometer usually occurs in short bursts of average duration of the order of half a minute.

There is evidence to suggest that the distribution of aircraft normal acceleration is not usually Gaussian, even for very short periods of time, but follows the form of a modified Bessel function, and gives rise to an exponential distribution of peak values. From the distribution of peak values the root-mean-square value of the variable (normal acceleration) can be determined. It is found that the root-mean-square tends to take one of two discrete values, the ratio between them being about 0.6.

Where the duration of turbulence has been measured directly, or can be inferred, the number of zero crossings per second of the variable can also be found from the peak distribution. Two examples of this are given, each for two intensities of turbulence. The close agreement between the values in the two intensities of turbulence provides some evidence in favor of the view that the shape of the power spectrum is independent of intensity, at least over a limited range.

In one case the power spectrum has previously been determined and it is possible to estimate the total time spent in turbulent conditions. From author's summary

334. Coleman, T. L., Press, H., and Meadows, May T., An evaluation of effects of flexibility on wing strains in rough air for a large swept-wing airplane by means of experimentally determined frequency-response functions with an assessment of random-process techniques employed, *NACA TN* 4291, 49 pp. + 4 tables + 18 figs., July 1958.

Power spectral methods are applied to flight test strain response measurements to determine the effects of aircraft flexibility on wing strain responses. Results indicate significant amplification of bending and shear strain responses, up to 100 per cent at the midspan station. Amplifications appear larger for high-altitude tests and appear predominantly associated with the first wing-bending mode.

Reliabilities of spectrum and cross-spectrum methods for determining frequency-response functions from flight measurements in continuous rough air are discussed in detail. Particular attention is directed toward evaluation and avoidance of the significant distortions which can be introduced into experimentally determined frequency-response functions by instrument and reading errors, side and head-on gusts, and spanwise gust variations.

R. F. Smiley, USA

335. Perkins, P. J., Icing frequencies experienced during climb and descent by fighter-interceptor aircraft, *NACA TN* 4314, 19 pp. + 11 figs., July 1958.

Vibration and Wave Motion in Fluids

(See also Revs. 123, 124, 251, 512, 568, 570, 572)

336. Miles, J. W., On the sloshing of liquid in a flexible tank, *J. appl. Mech.* **25,** 2, 277–283, June 1958.

Kinetic and potential energies of an incompressible fluid having a free surface in a cylindrical tank subjected to translation, rotation, and simple bending are derived and the results are illustrated by a calculation of the frequency equation for coupled bend-

ing and free-surface motion. It is found that if the mass of the empty tank is smaller than that of the liquid and the depth of the liquid is equal to the tank diameter the free surface increases the bending frequency (compared with frequency of a tank closed with a plane cap) by about 5% for cantilever bending oscillations and 27% for free bending oscillation. Results are demonstrated in two examples. References are made to H. Lamb, E. W. Graham, K. Kachigan, J. Lorell, Th. von Karman-M. A. Biot, and to basic research of Poisson, Lagrange and Rayleigh.

J. J. Polivka, USA

337. Bretschneider, C. L., Selection of design wave for offshore structures, *Proc. Amer. Soc. civ. Engrs.* **84,** WW2 *(J. Wwys. and Harbors Div.)*, Pap. 1568, 38 pp., Mar. 1958.

338. Simon, J. C., and Devimeux, C. W., Note on the analytical study of the phenomenon of tidal bores (in French), *Rev. gén. Hyd.* **22,** 78, 129-136, May/June 1957.

A short exposition of the theory of bores in both the linear and the hydraulic shallow water approximation is given. It is observed that in the first theory the slope of the bore decreases due to dispersion, whereas in the second case it is expected to steepen due to the larger wave speed behind the bore. It is suggested that cancellation of these effects might be the cause of the relative stability of observed bore profiles.

L. J. F. Broer, Holland

339. Rozental, A. I., Instrument for measuring wave height in hydraulic launders (in Russian), *Trudi n.-i. in-ta osnovanii i fundamentov* no. 25, 125-128, 1955; *Ref. Zh. Mekh.* no. 4, 1957, Rev. 4540.

340. Rodionov, B. L., Analysis and calculation of a pneumatic wavebreaker (in Russian), Avtoref. diss. kand. tekhn. Nauk, Leningr. in-ta inzh. vod. transp. (Thesis, Leningr. Inst. of Water Transport Engng.) Leningrad, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3093.

Fluid Machinery

(See also Revs. 283, 455, 485)

Book—341. Kovalev, N. N., and Kviatkovskii, V. S., Hydraulic turbine construction in USSR [Gidroturbinostroienie v SSSR], Moscow-Leningrad, Gosenergoizdat, 1957, 152 pp. $1.20.

A comprehensive report on the progress of turbine construction includes an historical sketch of the development of types of turbines, of the theoretical methods of investigations and experimental tests, almost exclusively by the Russian scientists and engineers, development of construction of large-size turbines in the Leningrad turbine factory, and the production of small turbines elsewhere. Reference list contains 220 works, among them 49 German, 12 English, 7 French. Paper is an important publication for power engineers. S. Kolupaila, USA

342. Sabaneev, A. A., On an nonmodelable feature of a water turbine (in Russian), *Izv. Vses. n-i. in-ta gidrotekhn.* **54,** 151-161, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 554.

Work experiments on models of hydroturbines are carried out with an outflow of water into the channel of such a large size that its velocity is practically equal to zero and the free surface is horizontal. Under natural conditions the velocities in the lower water, as a rule, are significant, and at the outlet of the suction pipe of the turbine the bottom of the lower water generally has a reverse slope along some of its length. As a result, observations were made in the section of the outlet of the turbine flow from the suction tube of the turbine on the drop in level of the water (the kinetic energy of the flow is not reestablished at the outlet section, but further on) compared with the actual markings of the lower water, which observations have no place when carrying out tests with laboratory apparatus. A method for determining this drop in level is advanced and a calculation of the occurrence described in recalculating the (k.p.d.) efficiency of the turbine from the model and when working in natural conditions. A numerical example showed that to ignore this occurrence resulted in the lowering of the (k.p.d.) efficiency in natural conditions by 2-3%. However, the theory and calculations put forward by author are based on suppositions which have not been fully verified (the hydrostatic distribution of pressure in the outlet section of the suction tube, the numerical values of Boussinesq's coefficient, combined with the little-studied distribution of velocities in the lower water, and so forth). N. A. Kartvelishvili

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

343. Aleksapol'skii, D. Ya., Influence of the coefficient of velocity and pump dimensions on the (k.p.d.) efficiency of centrifugal pumps (in Russian), Sb. tr. Labor. problem bystrokhod. mashin i mekhanizmov Akad. Nauk USSR, no. 5, 34-74, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 555.

The coefficient of velocity n_s does not by itself determine the constructive relationship of the working parts of turbopumps. Thus, for instance, with one and the same value for n_s it is possible to have different dimensions for the blade angles, different ratios of the outer diameter (D_2) and inlet diameter (D_o) of the working wheel, and in other cases. In the current study when analyzing the influence of the coefficient of velocity on the (k.p.d.) efficiency of the pump, attention has been given to the geometrical and kinematic features of the machines being compared, determining their structural relationship. Author's analysis shows that losses in the impeller of the pump depend on the coefficient of velocity and on the coefficient of static pressure (head) ρ. Losses in the spiral outlet with a diffuser hardly depend on ρ, but depend principally on n_s. The hydraulic (k.p.d.) efficiency n_s only depends on the pump dimensions and not on Reynolds number. In the limits $n_s = 100 \div 300$ the hydraulic (k.p.d.) efficiency of pump n_s does not depend on n_s and falls a great deal when $n_s < 100$. V. I. Kirsanov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

344. Jefferson, J. L., and Turner, R. C., Some shrouding and tip clearance effects in axial flow compressors, *N. E. Cst. Instn. Engrs. Ship. Trans.* **74,** 5, 235-284, Mar. 1958.

The paper, with a reference to the economics of blade manufacture, explains the reasons for the main series of tests, which were carried out at the National Gas Turbine Establishment. Four series of tests are described in detail. Various combinations of shrouding and tip clearance were investigated, untwisted constant-section blading being used in the first three series. The experiments were carried out over a range of shrouding leakage clearances, and also included an investigation of the boundary-layer flow on the convex surface of a stator blade in the compressor. A brief review of published work on the effects of normal radial tip clearance is followed by a description of some early results obtained on a multi-stage compressor. It is concluded that shrouding of the type investigated should, if possible, be avoided, especially under certain aerodynamic conditions. If it must be used, the clearance should be maintained at the smallest practicable value. The use of very fine radial tip clearances may also result in a loss of performance, although values in excess of 1% of the blade height are also shown to be undesirable in the particular case investigated. From authors' summary

345. Horlock, J. H., Experimental and theoretical investigations of the flow of air through two single-stage compressors, *Aero. Res. Counc. Lond. Rep. Mem.* 3031, 10 pp. + appendix + 40 figs., 1957.

The accuracy of actuator-disk theory in predicting the performance of axial-flow compressors is investigated experimentally. Pressure and velocity (with yaw probe) traverses permit comparison of measured with predicted axial velocity profiles. Results are generally good for ratios of vane radius/tip radius between 0.55 and 0.85, supporting the relevancy of the actuator-disk theory.

W. E. Ibele, USA

346. Artsykov, A. P., Problem of selecting the optimum axial flow velocities in calculating the stages of an axial fan (in Russian), *Trudi Leningr. korablestroit. in-ta* no. 17, 110–119, 1955; *Ref. Zh. Mekh.* no. 4, 1957, Rev. 4149.

Data are given relating to the experimental determination of the optimum value of the axial velocity in two models of single-stage axial fans with rectifying apparatus, which differ by the coefficients of high speed. A system of relationships of the efficiency of the fans to the mass flow of air, the angle of setting of the working blades and of the coefficient of use of the dynamic pressure was plotted. An empirical formula for determining the optimum axial velocity from the fan parameters was obtained.

V. D. Sokolov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

347. Denisenko, P. S., Axial fans with blades altering their pitch in motion and the outlook for their adoption (in Russian), *Trudi Kievsk. gidromelior. in-ta* **4,** 79–97, 1954; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1782.

The importance is noted of stepping up the economical operation of smoke extractors and fans used in electric power stations. It is shown that in a considerable number of cases, in places where GOST 5308-50 are in use, use could be made of axial single-stage fans, fitted with pitch-changing while-in-motion regulators. The test fan of this type with a wheel diameter of 1.3 m (n = 1460 revs/min) was designed and made under the supervision of the author of this article. The wheel has sixteen shaped involuted open blades made of sheet steel fixed to rods which can rotate simultaneously by means of a corresponding mechanical device while the fan is in motion. A maximum value of 0.73 was obtained for the k.p.d. (coefficient of useful action) for an air output of 94,000 m^3/hr and a pressure generation (calculated on cold air) of ~ 225 kg/m^2. The test fan worked for over two months in the boiler room of the 3rd Leningrad GEC and proved to be sufficiently dependable and more economical than the centrifugal fans previously employed. It has to be stated that fans with adjustable blades while in motion do not find a wide field of use in consequence of the complicated nature of the regulating mechanism. Much simpler are the axial fans with blades fixed immovably on the wheel and regulated by directing appliances, the parameters of which the author does not investigate.

A. G. Bychkov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

348. Powell, R. D., Jr., and Carpenter, P. J., Low tip Mach number stall characteristics and high tip Mach number compressibility effects on a helicopter rotor having an NACA 0009 tip airfoil section, *NACA TN* 4355, 15 pp. + 11 figs., July 1958.

An investigation has been conducted on the Langley helicopter test tower to determine experimentally the low tip Mach number maximum mean lift coefficient and high tip Mach number compressibility effects on a helicopter rotor having an NACA 0009 airfoil tip section, an NACA 0017 airfoil root section, and 5.4° of negative twist. Data, presented for blade-tip Mach numbers ranging from 0.28 to 0.72 (corresponding blade-tip Reynolds number range of 1.65×10^6 to 4.29×10^6), have been compared with two-dimensional data as well as with other rotor experimental data.

From authors' summary

349. Alexeyeva, R. N., Likhovetsky, I. D., and Rzheznikov, Yu. V., Experimental methods of testing relatively short turbine blades and determining their profiles (in Russian), *Teploenergetika* **6,** 51–56, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2910.

The results are communicated of an investigation into the influence of inhomogenity of the flow at the nozzle outlet on the losses in short, turbine rotor blades (aspect ratio l/b = 0.2 – 1.0).

Five flat profile cascades of the reaction type were tested (1) with a shroud (depth of the cascade greater than the depth of the guide ring); (2) with a shroud and suction control of the boundary layer on the guide-blade ends; (3) with interception of the boundary layer at the guide-blade ends.

Three cascades were tested with different development of the guide duct profile in height. The change in efficiency over the depth of the blade, in relation to the thickness of the boundary layer at the entry, was investigated. For one cascade the pressure distribution along the contour at the middle of the depth was investigated, as well as the variation in efficiency depending on the angle of entry and the Mach number.

The dimensions and geometrical proportions are indicated of profile and guide duct sections in depth, exhibiting higher efficiencies.

It is noted that in the presence of a boundary layer at the entry, with a thickness of, for instance, 6% of the depth at the middle of the blade, there is a loss region at that point.

Neither the angles of exit nor the Reynolds numbers at which the determinations were made are indicated.

V. L. Epshtein

Courtesy of Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Flow and Flight Test Techniques and Measurements

(See also Revs. 161, 250, 331, 333, 341, 527, 532)

350. Williams, J. L., and Eveson, G. F., A vibrating condenser manometer, *J. sci. Instrum.* **35,** 3, 97–99, Mar. 1958.

The principle of the use of a vibrating capacitor to measure small displacements has been applied in an instrument to record cyclic fluctuations of air pressure. A summary is made of the results of simple experiments carried out to investigate factors influencing the amplitude of the signal generated by a vibrating capacitor. A description is given of a simple, robust instrument which has been used to measure fluctuating air pressures and reference is made to the characteristics of the instrument.

From authors' summary

351. Leck, J. H., A feedback controlled Pirani gauge, *J. sci. Instrum.* **35,** 3, 107–108, Mar. 1958.

Paper describes a simple feedback circuit for the Pirani gage in which the power supply to the Wheatstone bridge is adjusted automatically so as to keep the wire temperature approximately constant over a wide range of pressure changes. This is achieved by supplying the power from a d c amplifier which is itself controlled by changes in wire temperature, a small fall in temperature serving to increase the power output from the amplifier. A transistor is employed as the input stage of the amplifier. The comparatively large zero drifts in the transistor d c amplifier due to temperature changes are no particular disadvantage in this application as the Pirani gage signal is also dependent upon ambient temperature.

From author's summary

352. Ushakov, V. N., Measurement of the flow velocity in a high-vacuum, oil-vapor pump (in Russian), Avtoref. diss. kand. tekhn. nauk., Mosk., inzh.-fiz. in-ta, M., (Thesis, Moscow Inst. Engng. Physics, Moscow, 1955); *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2998.

353. Keller, S. Yu., The impulse-meter and an investigation of its work (in Russian), *Nauch. zap. Lvovsk. s.-kh. in-ta* **5,** 296–310, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3312.

354. Sreekantath, G. M., and Verghese, C. A., A compensated moving cylinder viscometer, *J. sci. Instrum.* **35,** 5, 160–161, May 1958.

Based on the principle of Lawaczeck's falling cylinder viscometer, a new viscometer has been designed in which the only measurement to be made is the time taken by the cylinder to move a definite distance, without the necessity of either observing the movement of the cylinder or measuring the densities of the cylinder and of the liquid. The instrument consists of two exactly similar light solid cylinders or cylindrical bulbs moving in similar vertical tubes of slightly larger diameters containing the liquid at the same temperature. The ends of each cylinder are made conical to ensure its coaxial movement in the tube and the cylinders are attached to the ends of a Nylon fiber which passes over a light frictionless pulley. Attached to the same fiber at suitable heights above the cylinders are two similar light weight carriers on either of which riders of equal mass may be placed. When a certain number of riders are placed on one side, the cylinder on that side moves down while the other cylinder moves up with uniform speed, the pulley turning round once in a time T which is directly proportional to the viscosity of the liquid. This result may be used to compare the viscosities η_1 and η_2 of two liquids using the same number of riders and noting the times T_1 and T_2 respectively for a complete rotation of the pulley. $\eta_1/\eta_2 = T_1/T_2$.

The instrument is capable of high accuracy and has the special feature that a knowledge of the density of the liquid is not needed in the calculation of the result.

From authors' summary

355. Katzoff, S., and Barger, R. L., Boundary-induced downwash due to lift in a two-dimensional slotted wind tunnel, *NACA TN* 4289, 15 pp. + 8 figs., June 1958.

A practical mathematical method is described for determining the flow in a two-dimensional slotted wind tunnel containing a lifting wing. Calculated results are given for the longitudinal distribution of tunnel-induced angles for various slot geometries and for various vertical locations of the wing in the tunnel. Some quantitative discussion is given of the application of these results to the testing of three-dimensional lifting models in a tunnel with closed side walls and slotted top and bottom.

R. C. Binder, USA

356. Campbell, J. P., Techniques for testing models of VTOL and STOL airplanes, *AGARD Rep.* 61, 17 pp. + 27 figs., Aug. 1956.

357. Smith, A. G., Wind-tunnel tests on seaplane hulls in R.A.E. 5-ft. diameter open jet tunnel and N.P.L. compressed air tunnel, *Aero. Res. Counc. Lond. Rep. Mem.* 3018, 16 pp. + 13 tables + 36 figs., 1957.

358. Gracey, W., Summary of methods of measuring angle of attack on aircraft, *NACA TN* 4351, 15 pp. + 14 figs., Aug. 1958.

Wind-tunnel calibrations of three types of angle-of-attack sensing devices—the pivoted vane, the differential pressure tube, and the null-seeking pressure tube—are presented. Flight data on the position errors of three sensor locations—ahead of the fuselage nose, ahead of the wing tip, and on the forebody of the fuselage—are also presented. Various methods for calibrating angle-of-attack installations in flight are briefly described.

From author's summary

359. Beeler, D. E., Flight loads measurements on NACA research airplanes, *AGARD Rep.* 109, 10 pp. + 23 figs., Apr./May 1957.

Flight loads investigations are conducted primarily for the purpose of confirming wind-tunnel results by comparing the full-scale results with comparable wind-tunnel results as frequently as deemed necessary; assessing the maneuvering conditions required of the aircraft and determining the associated dynamic loading conditions for the maneuvers; and bringing to light loads problems as a result of conducting flight research. The research airplane program in the United States included from the beginning extensive programs on flight loads measurements. This report summarizes some of the results from these investigations for three aircraft: the X-1 rocket-powered airplane; the X-5 variable-sweep airplane; and the XF-92A delta-wing airplane.

From author's summary

360. Chinneck, A., and North, Mrs. N. A., Some experiments with sonic throats downstream from the working-section of a slotted-wall high-speed tunnel, *Aero. Res. Counc. Lond. Rep. Mem.* 3053, 12 pp. + 35 figs., 1957.

Tests have been made in the National Physical Laboratory 9-in. × 3-in. high-speed tunnel to investigate the use of sonic throats downstream from the working-section of a slotted-wall high-speed tunnel employing diffuser suction. It was found that such throats behaved at subsonic speeds in a manner similar to their behavior in a solid-wall tunnel. The Mach number in the working-section was approximately that to be expected from the ratio of the area between walls, at the beginning of the slots, to the area at the throat.

Tests were made with various configurations, including the conditions which could be expected on the 18-in. × 14-in. and 36-in. × 14-in. high-speed tunnels at the N.P.L. It was found that the throat mechanisms at present used with the subsonic liners on these tunnels should work satisfactorily, and that the power required should be of the same order as that required to run the unchoked slotted walls at unit Mach number.

Information has also been obtained on the beneficial effects to be obtained from (*a*) an improvement in the pressure recovery downstream from the parallel slotted length of the working-section and (*b*) a reduction in the slope of the upstream face of the sonic throat.

From authors' summary

361. Moss, G. F., Low-speed wind-tunnel measurements of longitudinal oscillatory derivatives of three wing planforms, *Aero. Res. Counc. Lond. Rep. Mem.* 3009, 10 pp. + 8 tables + 26 figs., 1957.

Tests have been made on a 90° apex delta wing, a 60° sweptback wing and a 40° sweptback wing to obtain values of longitudinal oscillatory derivatives for various frequencies, amplitudes and Reynolds numbers. Values of m_0 were obtained for all three models and z_w for the delta model using free oscillation methods. In addition, $z_{\dot{\alpha}}$, $z_{\dot{\beta}}$, $m_{\dot{\alpha}}$ and $m_{\dot{\beta}}$ were measured by a forced oscillation method for the delta wing and the 60° sweptback wing.

The effects of reduced frequency (over the range 0.01 to 0.3), amplitude (± ½ deg to ± 2 deg in pitch) and Reynolds number (0.72×10^6 to 3.3×10^6) were found to be small.

From author's summary

362. Mansell, C. J., Low-speed wind-tunnel tests on two thin cranked wings with 60-deg sweepback inboard, *Aero. Res. Counc. Lond. Rep. Mem.* 2995, 6 pp., 13 tables + 34 figs., 1957.

Low-speed wind-tunnel tests have been made on two thin wings

of aspect ratio 3 with 60° leading-edge sweep at the root. Both wings show large forward movements of the aerodynamic center at moderate lift coefficient (C_L = 0.5 to 0.7). This forward movement can be delayed to C_L = 1.0 by full-span Kruger-type leading-edge flaps. The normal type of split flap with hinge-line parallel to the wing trailing edge gave a decrease in usable C_L and better results were obtained with flaps with their hinge-line skewed to the wing trailing edge at a smaller angle of sweepback. With skewed split flaps and full-span nose flaps C_L = 1.2 at $\alpha = 17\frac{1}{4}$ deg was reached on both wings with only small movements of the aerodynamic center.

Abrupt changes in l_v and n_v with change of incidence occurred in the region of flow breakdown on the wing without flaps. These abrupt changes were postponed to $C_L > 1$ by nose flaps and skewed trailing-edge flaps. Ailerons with unswept hinge-line produced greater rolling moments than ailerons with swept hinge-lines or all-moving tip ailerons.

The Reynolds number of the tests was about 2.3×10^6 and the Mach number 0.18. Some favorable scale effects would be expected at higher R, but the general nature of the breakdown of flow will probably be similar on a full-scale airplane.

From author's summary

363. Williams, W. C., Drake, H. M., and Fischel, J., Some correlations of flight-measured and wind-tunnel measured stability and control characteristics of high-speed airplanes, *AGARD Rep.* 62, 6 pp. + 9 figs., Aug. 1956.

364. Stanbrook, A., Nozzle and contraction shapes of the R. A. E. 3 ft. × 3 ft. supersonic wind tunnel, *Aero. Res. Counc. Lond. curr. Pap.* 375, 4 pp. + 2 tables + 1 fig., 1957.

365. Huber, P. W., Note on hydrogen as a real-gas driver for shock tubes, *J. aero. Sci.* **25,** 4, p. 269 (Readers' Forum), Apr. 1958.

366. Adamskii, V. B., Integration of a system of self-similar equations in the problem of a shock of short duration in a cold gas (in Russian), *Akust. Zh.* **2,** 3–9, 1956.

The problem of propagation of a pressure pulse in a shock tube, half filled with quiescent gas in an initially uniform state, is considered, following earlier work by Zeldovich [*Akust. Zh.* **2,** 1, 28–38, 1956]. A similarity hypothesis is employed in which all physical quantities depend only on the single variable $\eta = m/M$, where

$$m = \int_{-\infty}^{x} \rho dx = \rho_0 y, \quad M = \rho_0 X;$$

x, y are Eulerian and Lagrangian distances respectively, measured along the shock tube, X is the Eulerian coordinate at the shock, and ρ_0 is the initial gas density.

The pressure, velocity and density may then be written in the form

$$p = A\rho_0 M^{-n} f(\eta), \; u = A^{-1/2} M^{-n/2} u(\eta), \; \rho = \rho_0 q(\eta),$$

respectively. The Lagrangian equations of motion can then be reduced to ordinary differential equations for f, u and q. The solutions of these satisfying the shock wave conditions on $\eta = 1$ are found and shown graphically. M. Holt, USA

367. Russo, A., and Hertzberg, A., A method for improving the performance of shock tubes, *Jet Propulsion* **27,** 11, 1191–1193, Nov. 1957.

A survey is given on some known methods to augment final shock strength in air for a given shock tube configuration with given pressure ratio. As increase of the acoustic velocity of the driving gas increases the strength of the shock waves generated, and as high acoustic velocities may be obtained by use of combustible mixtures of hydrogen and oxygen diluted with helium, or by the use of low molecular weight gases such as hydrogen and helium, such methods may be based on a suitable choice of the driving gas. But they all have their specific disadvantages; the combustion driver requires extreme care in its use to counteract its erratic tendency, the hydrogen driver involves certain hazards at high pressure and introduces flow disturbances by the combustion at the hydrogen-air contact surface, the helium driver has lower efficiency than the hydrogen driver.

Other methods of improvement are therefore based on certain shock tube modifications. Two of them are the double-diaphragm shock tube with an inert buffer gas between the driving hydrogen and the air, and the shock tube with an area contraction at the diaphragm station. Both may be combined, with the area contraction at the downstream diaphragm. Monatomic gases are preferable as they minimize real gas effects in the buffer zone. The effects of buffer gas atomic weight and of varying buffer gas pressure on the final shock strength are discussed with the result that the combination of the double-diaphragm tube with a monatomic buffer gas of the proper atomic weight and a large area contraction at the downstream diaphragm station will give an appeciable gain in final shock strength (which can not be obtained by contraction alone). Moreover, by selecting the proper buffer gas it is possible to control the downstream diaphragm pressure ratio to minimize the mass of the downstream diaphragm and thus to reduce the loss in testing time and the interference of the bursting diaphragm with flow establishment. H. Behrbohm, Sweden

368. Phillips, W. H., Kuehnel, H. A., and Whitten, J. B., Flight investigation and the effectiveness of an automatic aileron trim control device for personal airplanes, *NACA Rep.* 1304, 15 pp., 1957.

An analytical and flight investigation has been made to determine the effectiveness of an automatic aileron trim control device in conjunction with preloaded aileron centering springs in improving spiral stability characteristics of a personal airplane. The results indicate that the device can maintain the airplane in level flight under instrument conditions despite disturbances due to moderate turbulence or trim changes with airspeed and flight condition. From authors' summary

369. Head, M. R., Johnson, D., and Coxon, M., Flight experiments on boundary-layer control for low drag, *Aero. Res. Counc. Rep. Mem.* 3025, 15 pp. + 2 tables + 32 figs., 1957.

Tests have been made with distributed suction applied to a short-span sleeve fitted to the upper surface of the wing of a single-seat *Vampire* aircraft. Full-chord laminar flow was maintained up to Reynolds numbers in the region of 29 million and Mach numbers up to 0.70, which was very nearly the critical Mach number of the sleeve section. The suction quantities required were sufficiently small to result in over-all reductions in profile drag of between 70 and 80%, account being taken of the power required for suction. Difficulties were experienced due to surface roughness, and although these are believed to have resulted largely from the particular type of porous covering used in the tests, the problem of maintaining a sufficiently smooth and clean surface is evidently of crucial importance to full-scale application.

From authors' summary

Thermodynamics

(See also Revs. 316, 365, 416, 419, 449, 455, 505, 509)

370. Gevorkin, R. G., On the entropy of thermodynamic systems (in Russian), *Trudi Mosk. aviats. tekhnolog. in-ta* no. 26, 71–99, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2619.

371. Alexeev, V. P., and Martynovsky, V. S., The effect of turbulent separation of superheated vapor and an experimental confirmation of the Hilsch-Fulton hypothesis (in Russian), *Izv. Akad. Nauk SSSR, Otd. tekh. Nauk* no. 1, 71–79, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3011.

It is observed that the effect of temperature separation is impaired by working with humid air. The results of test made in a 9-mm turbulence tube, with carbon dioxide, methane, ammonia, and dry air are described. Special experiments were made to verify the Hilsch-Fulton hypothesis.

Authors' experiments fundamentally confirm this hypothesis, but substantial divergences have also been observed, associated with the manner of distribution of the angular velocities.

M. G. Dubinskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

372. Hansen, C. F., and Heims, S. P., A review of the thermodynamic, transport, and chemical reaction rate properties of high-temperature air, *NACA TN* 4359, 19 pp. + 21 figs., July 1958.

Thermodynamic and transport properties of high-temperature air, and the reaction rates for the important chemical processes which occur in air, are reviewed. Semiempirical, analytic expressions are presented for thermodynamic and transport properties of air. Examples are given illustrating the use of these properties to evaluate (1) equilibrium conditions following shock waves, (2) stagnation region heat flux to a blunt, high-speed body, and (3) some chemical relaxation lengths in stagnation region flow.

From authors' summary

373. Ashton, H. M., and Halberstadt, E. S., Refractivity of gases and its use in calculating virial coefficients, *Proc. roy. Soc. Lond. (A)* **245,** 1242, 373–381, June 1958.

Precision measurements of the refractive index of ethylene and neopentane over a pressure range 0 to 1 atm and a temperature range of 25 to 70C were made and used to calculate virial coefficients. Some measurements on air and *n*-hexane are also reported. Certain aspects of the use of the Rayleigh refractometer are discussed.

From authors' summary

374. Waelbroeck, F. G., and Zuckerbrodt, P., Thermal conductivities of gases at low pressures. I. Monatomic gases, helium and argon, *J. Chem. Phys.* **28,** 3, 523–524, Mar. 1958.

375. Waelbroeck, F. G., and Zuckerbrodt, P., Thermal conductivities of gases at low pressures. II. Rotational relaxation time in hydrogen and oxygen, *J. Chem. Phys.* **28,** 3, 524–526, Mar. 1958.

376. Ishikawa, T., Further notes on the ideal mixture law for viscosity, *Bull. Chem. Soc. Japan* **31,** 5, 524–529, July 1958.

377. Novikov, I. I., A relationship for the viscosity and thermal conductivity of liquids and gases, *J. Nuclear Energy* **6,** 4, p. 370, May 1958. (Translated by L. Bovey from *Atomnaya Energiya* **2,** p. 468, 1957.)

378. Bartenev, G. M., Thermodynamic theory of the deformation of highly elastic materials (in Russian), *Zh. eksp. teor. Fiz.* **25,** 2, 225–234, 1953; *Ref. Zh. Mekh.* no. 4, 1957, Rev. 4762.

Author attempts to describe the deformation of highly elastic materials (rubbers) according to general thermodynamic theory. The equation of state is analyzed for single axis deformation, and the meaning of the values coming into the equation is clarified. It is asserted that the experimental check shows that the equation obtained expresses the connection between the stress and the deformation much better than the relationships obtained by other investigators.

A. P. Bronskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Book—379. Godnev, I. N., Computation of thermodynamic functions using molecular data (in Russian), Moscow, Gosudarstv. Izdat. Tekh.-Teor. Lit., 1956, 419 pp. 13.45 rubles.

The present rapid progress of technology demands a steady supply of numerical data on the thermodynamic properties of various substances. These can be obtained either experimentally or by calculation, from suitably established models, on the basis of statistical and quantum mechanics. The present volume attempts to collect in one place the most important Russian developments on this subject. Some references to Western work are included in the voluminous bibliography containing 268 titles. References to Chapman and Cowling, to the work done by J. Hirschfelder and his associates, and to the recent Nat. Bur. Standards "Tables of thermodynamic properties of gases" (published in 1956 but available in several reports since 1952) are conspicuously absent.

The subject matter covered by the book can be inferred from the titles of its fourteen chapters: 1. Fundamental equations of statistical thermodynamics. 2. Application of the fundamental equations of statistical thermodynamics to perfect gases. 3. Thermodynamic functions for monatomic gases. 4. Equations for the energy and state of diatomic gases. 5. Calculation of the thermodynamic properties of diatomic gases. 6. Classification and types of symmetry in polyatomic gases. 7. Equations for the rotational and vibrational energy of quasi-rigid molecules. 8. Calculation of the thermodynamic properties of (ensembles of) quasi-rigid molecules. 9. The thermodynamic properties of gases for the case of free rotation. 10. Calculation of the thermodynamic properties of gases for the case of inhibited internal rotation. 11. Calculation of the thermodynamic properties of real gases, liquids, and solids with the aid of the corresponding functions in the perfect-gas state. 12. Calculation of chemical equilibria. 13. The calculation of the equilibrium constants for reactions involving isotopes. 14. Tables.

The chapter on real gases (chap. 11) is entirely based on the use of the Berthelot equation together with the classical equations of thermodynamics and ignores the existence of methods of evaluating virial coefficients by statistical considerations. The very important field of the calculation of transport properties is left unmentioned.

The book is well written and succeeds in presenting its material in a simple, vivid manner, but the reader is left in the dark as to the quality of the agreement with measured data which may be expected from the calculations described. Admittedly, a systematic comparison between the various statistical approximations and existing experimental results, even for gases alone, would present formidable difficulties, but it is a task that is long overdue.

J. Kestin, USA

Book—380. Kogan, V. I., and Galickii, V. M., Collection of problems on quantum mechanics (in Russian), Moscow, Gosud. Izdat. Tekh.-Teor. Lit., 1956, 415 pp. 7.15 rubles.

Authors group 164 problems from the nonrelativistic quantum mechanics in 12 chapters and provide completely detailed solutions. Being written for students of atomic and nuclear physics the book presupposes a good knowledge of the subject about in the extent covered by the well-known Russian textbooks by Blokhintzev or Landau and Lifschitz.

Most questions will probably prove difficult to a reader unacquainted with the methods of wave mechanics. This is to be seen in the fact that mathematical and physical statement of all problems covers only 24 pages, whereas the whole remaining part of the book had to be devoted to the solutions. In addition

to the usual material the book contains such special questions as the Heisenberg conception of operators, isotropic spin, etc.

W. A. Nash, USA

381. Brinkman, H. C., Nonlinear irreversible thermodynamics of Brownian motion (in English), *Physica* **24,** 6, 409–414, June 1958.

Thermodynamics of a system far from equilibrium is studied in the simple case of Brownian motion. From Kramers' theory one finds free energy as a function of time, and hence Onsager's relations, although microscopic reversibility is not introduced explicitly.

P. E. Kriezis, Greece

382. Kraichnan, R. H., Irreversible statistical mechanics of incompressible hydromagnetic turbulence, *Phys. Rev.* (2) **109,** 5, 1407–1422, Mar. 1958.

The irreversible statistical mechanics of incompressible hydromagnetic turbulence driven by external forces is treated by methods which do not require that the system be close to a state of detailed balance. The equations of motion are expressed in terms of linearly independent modes formed from the wave-vector components of velocity and magnetic fields, and the nonlinear interaction is exhibited as the sum of individually conservative three-mode interactions. A fundamental statistical equation is constructed giving necessary and sufficient conditions for all members of a distribution of time-functions to satisfy the equations of motion; it involves only second-, third-, and fourth-order distribution moments. A variational criterion is proposed for specifying a distribution consistent with the fundamental equation under physically appropriate constraints. It leads to a complete formal solution of the statistical problem. This solution is not exploited. Instead, two statistical hypotheses based on the assumption of high mode density are advanced. With their aid, each three-mode interaction is treated as a small perturbation on the motion due to all the three-mode interactions and the external forces. The moments in the fundamental equation for the stationary case thereby are expressed in terms of the diagonal elements of the time-covariance matrix and distribution-averaged infinitesimal-impulse-response matrix of the system. Closed equations are obtained which fix these matrix elements in terms of the covariance matrix of the external forces. If the statistical hypotheses are sound, this provides a theory of unbounded turbulence (infinite mode density) driven by Gaussian-distributed homogeneous forces which is exact at all Reynolds numbers based on rms velocity and the macroscale determined by the driving forces. The general theory is specialized to obtain integro-differential equations determining the covariance scalars and modal impulse-response functions for stationary, isotropic hydromagnetic turbulence. In the nonmagnetic case, the asymptotic inertial-range solution yields the wave-number spectrum $E(k) = 2\pi c(\epsilon v_0)^{\frac{1}{2}} k^{-\frac{3}{2}}$ and the modal time-autocorrelation function $J_1(2v_0kr)/(v_0kr)$, where v_0 is the rms velocity in any direction, ϵ is the mean rate of energy-cascade/unit-mass, and c is a universal number fixed by the theory. This contradicts the Kolmogorov similarity hypotheses; independent arguments are advanced against the latter.

From author's summary

383. Davydov, B. I., Causes of thermodynamic irreversibility, (in Russian), *Soviet Phys.-JETP* **6,** 3, 625–626 (Letters to the Editor), Mar. 1958. [Translation from *Zh. eksp. teor.-Fiz.* **33,** p. 811, 1957 by Amer. Inst. Phys., New York, N. Y.]

Heat and Mass Transfer

(See also Revs. 42, 52, 138, 139, 244, 276, 281, 371, 419, 436, 504, 516, 539, 544)

384. Mirsepassi, T. J., Heat-transfer charts for time-variable boundary conditions. I. Semi-infinite solid, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-7, 29 pp.

Charts are presented to enable a convenient graphical evaluation of the transient temperature distribution of a semi-infinite solid initially at a uniform temperature and subject to either a time-variable surface temperature or a time-variable heat flux at the accessible face. A procedure is given for determining the surface temperature and heat flux when the temperature is given as a function of time at a given point in the solid. The charts are based on a graphical integration of Duhamel's solution and cover the range of the Fourier number $0.005 \leq N_{F_0} \leq 20$ based on the distance from the accessible flow.

E. Sunderland, USA

385. Glikman, V. F., On the problem of nonstationary heat transfer through a plate, *Soviet Phys.-Tech. Phys.* **2,** 12, 2593–2595, Dec. 1957. [Translation of *Zh. Tekh. Fiz. Akad. Nauk SSSR* **27,** 12, 2794–2796, July 1958, by Amer. Inst. Phys., Inc., New York, N. Y.]

Transient conduction through a plate is analyzed for arbitrary convective boundary conditions on each side. Using Laplace transforms an analytic solution for the case of constant initial plate temperature is obtained.

P. M. Lang, USA

386. Frank, I., Transient temperature distribution in aircraft structures, *J. aero. Sci.* **25,** 4, 265–267, Apr. 1958.

Author presents analytical solution for conventional symmetrical two-skin-and-channel stiffener configuration reduced to a T by simplifying assumptions: (1) Structural members are thermally thin; (2) joint heat conductance can be represented by analytical convective heat relations; (3) no internal radiant or (nonjoint) convective heat transfer; (4) thermal conduction properties independent of temperature; and (5) heat capacity of stiffener flange is negligible. Heat input (to one surface or symmetrical to both surfaces) may be expressed as a polynomial function of time. Validity of assumptions is confirmed by good agreement of theoretical results with experiment.

Method has advantages of analytical solutions: generality, and freedom from extensive numerical computation; it is therefore useful in area of temperature range, beam material thermal properties and beam geometries in which assumptions are justified.

S. Goodman, USA

387. Horvay, G., and Henzel, J. G., Freezing of liquid metal in a mold, Gen. Elec. Research Lab. Rep. 57-RL-1844, Class I, 59 pp. + iii, Dec. 1957.

The problem of freezing of a liquid metal in a mold is approached on the basis of the semi-infinite slab wherein the thermophysical properties of the solid metal, the liquid metal and the confining mold are considered different but independent of the temperature. Several calculated examples are given for various mold and melt materials. Calculated results are favorably compared with some available experimental results. Nomograms and charts are provided which permit rapid determination of the mold-ingot interfacial temperature and the speed of solidification of a semi-infinite melt cast into a semi-infinite mold.

R. M. Drake, Jr., USA

388. Redozubov, D. V., On linear heat problems with one moving boundary, *Soviet Phys.-Tech. Phys.* **2,** 9, 1993–2000, May 1958. [Trans. of *Zh. tekh. Fiz. Akad. Nauk SSSR* **27,** 9, 2149–2157, Sept. 1957, by Amer. Inst. Phys., Inc., New York, N. Y.]

Author resolves the one-dimensional heat problem with one moving boundary:

$$\frac{\partial u_1}{\partial t} = a_1^2 \frac{\partial^2 u_1}{\partial x^2},\ 0 < x < y(t);\quad \frac{\partial u_2}{\partial t} = a_2^2 \frac{\partial^2 u_2}{\partial x^2},\ y(t) < x < \infty$$

with the boundary and initial conditions:

$$u_1(0, t) = \varphi(t) \quad t > 0;$$
$$u_1[y(t)\, t] = u_2[y(t)\, t] = \psi(t), \quad t > 0;$$
$$u_2(x, 0) = f(x),$$

where the function $y(t)$ is the given law of motion of the boundary (with the condition $y(0) = 0$) and the function $f(x)$ is a given initial distribution. The necessity for solving this problem arises in certain engineering applications. The author extends the number of the solutions of the problem which can be treated by numerical methods. A. Pignedoli, Italy

389. Jung, H., Contribution to the theory of controlled heating processes (in German), *ZAMM* **38,** 1/2, 56–69, Jan./Feb. 1958.

A homogeneous isotropic solid at prescribed initial temperature and without sources of heat is surrounded by another medium with a given time variation of temperature. In contrast to the usual conception author assumes a linear dependence both of the conductivity and of the outer conductivity upon the temperature. The resulting nonlinear problem is linearized and solved by a suitable modification of the methods known from the theory of perturbations.

The influence of the nonlinearity is shown graphically on the concrete examples of a wall, hollow cylinder, and sphere. There has been found no essential influence on the first perturbation function.

Paper presents a fine contribution to the analytic theory of heat conduction. A more careful proof reading would have eliminated some unnecessary misprints.

V. Vodicka, Czechoslovakia

390. Libby, P. A., The laminar hypersonic heat transfer on a blunt body according to the integral method, Heat Transf. and Fluid Mech. Inst., Univ. of Calif., Berkeley, Calif., June 1958, 216–230.

Integral method is applied to momentum and energy equations under following assumptions: thermodynamic equilibrium; Lewis number unity; Prandtl number constant; product of density and viscosity constant; thermal layer thickness equals boundary layer thickness. Comparison with more exact theories shows satisfactory agreement (error not greater than 20%). Reviewer notes that error is less for Prandtl number unity than for Prandtl number 0.71. Accuracy might be improved for Prandtl numbers other than unity by assuming ratio of boundary-layer thickness to thermal layer thickness equals square root of Prandtl number.

T. R. Goodman, USA

391. Kreith, F., and Margolis, D., Heat transfer and friction in swirling turbulent flow, Heat Transf. and Fluid Mech. Inst., Univ. of Calif., Berkeley, Calif., June 1958, 126–142.

Swirl was communicated to flow through a straight pipe by means of a twisted metal ribbon along the axis, or alternatively, a coiled wire. Inside surface heat-transfer coefficients were found to increase as much as fourfold over coefficients observed at same velocity in purely axial flow. Coefficients were found to depend on centrifugal force component. However, at comparable Reynolds numbers and swirling motions, heat-transfer coefficients for water were found to be larger than coefficients for air. Reason for this difference is not definitely known, although qualitatively compatible with flow phenomena in a vortex type flow.

It is shown that phenomena are result of free convection motion induced by centrigufal force due to temperature difference in rotating fluid.

From authors' summary by H. S. Ribner, Canada

392. Gelin, P., Calculation of the Margoulis number in steady incompressible flow in a circular tube (in French), *Chaleur et Industrie* **39,** 392, 74–80, Mar. 1958.

The problem of forced heat convection from the walls of a circular tube into a steady-state fully developed turbulent flow is considered. Assuming a constant heat per unit area supplied into the walls, a simple differential equation is obtained for the temperature change within the fluid in terms of the velocity change, the Prandtl number, and the ratio of the local to the maximum velocity. Approximate solutions are found for the laminar sublayer, the buffer layer, the intermediate layer and the center of the pipe from universal behavior of the turbulent shear layer. Finally defining the Margoulis number as the ratio of Nusselt to Péclet, an expression for it is derived in terms of the friction coefficient at the wall and the local Prandtl number. This problem was solved in 1939 by von Kármán expressing the Stanton number in terms of the Prandtl number and the friction coefficient. The work of von Kármán appeared in the *ASME Trans.* **61,** pp. 705–710.

S. Eskinazi, USA

393. Stalder, J. R., A survey of heat transfer problems encountered by hypersonic aircraft, *Jet Propulsion* **27,** 11, 1178–1184, Nov. 1957.

Starting with general considerations, the steady-state heat balance on the aircraft skin is discussed under the assumption that no internal cooling is employed, the convective heat transfer into the surface due to aerodynamic heating being balanced by the radiant heat transfer outward from the surface only. In order to minimize the heat-transfer rate for a fixed flight speed, local air density and local Stanton number must be as low as possible. As equilibrium flight at a given hypersonic speed is confined to a narrow range of altitude, there remains the necessity of minimizing Stanton number. For this purpose the effects on Stanton number of such parameters as Mach number, Reynolds number, Prandtl number, transition Reynolds number, body surface to boundary-layer-edge temperature ratio, surface pressure gradient and wall temperature gradient, and Knudsen number are briefly discussed.

Author describes the application of these results to the calculation of the heat-transfer characteristics of a hypersonic aircraft, attention being focussed on the gliding type of such vehicles only. He mentions the powerful effect of sweepback on the heat transfer to the leading edge (and on the pressure drag), the effect of leading edge radius on average leading edge temperature and he outlines the difficulty of determining transition Reynolds number, the suitable choice of which, at the present state of the art, being little more than conjecture. Finally, some heat-transfer calculations taking account of dissociation are reviewed, and a table is given which compares some examples of values of heat-transfer rates and shock properties assuming perfect gas relations and assuming dissociation present. H. Behrbohm, Sweden

394. Sparrow, E. M., Combined effects of unsteady flight velocity and surface temperature on heat transfer, *Jet Propulsion* **28,** 6, 403–405 (Tech. Notes), June 1958.

Author studies the compressible boundary layer on a semi-infinite flat plate. Paper generalizes earlier work by Moore [AMR **5** (1952), Rev. 828] and Ostrach [AMR **9** (1956), Rev. 2372] on the effects of an unsteady flight velocity alone on the flow and heat transfer, and by Sparrow and Gregg [AMR **11** (1958), Rev. 623] on the effects of an unsteady surface temperature alone. The latter is assumed to have the same value at all points of the plate.

A formula for the instantaneous heat transfer is given and is valid for small deviations from the quasi-steady state. From this formula it appears that, in many cases of high-speed flow, the heat transfer is likely to be almost quasi-steady.

J. T. Stuart, England

395. Tsarenko, N. V., The nature of heat exchange in curved channels (in Russian), *Izv. Kievsk. politekhn. in-ta* **18,** 358–361, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3166.

Based on experimental data on the heat exchange in straight and curved pipes and a comparative analysis of the kinematic structure of a flow of a turbulent fluid within two-dimensional channels and square rectangular ducts, the conclusion is drawn that the heat emission in the turbulent flow of a fluid along curvilinear channels of rectangular cross section with a high aspect ratio ($b/h > 8$–9) may be described sufficiently accurately by the equation obtained for rectilinear channels:

$$N = 0.023\ R^{0.8}\ P^{0.4}$$

(N Nusselt number; R Reynolds number; P Prandtl number).

L. V. Kozlov

Courtesy of Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

396. Teverovskii, B. M., Influence of surface roughness on hydraulic resistance and convection heat exchange (in Russian), Avtoref. diss. kand. tekhn. nauk, Kuibyshevsk. industr. in-ta, Kuibyshev, 1956; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 2031.

397. Reid, W. H., and Harris, D. L., Some further results on the Benard problem, *Physics of Fluids* **1,** 2, 102–110, Mar.–Apr. 1958.

Paper is concerned with the cellular type of instability which occurs in a horizontal viscous fluid layer contained between two rigid planes and heated from below. The purpose of the work is to present two approximate analytical methods which can be used to solve this type of stability problem. Since the exact solution is already known, it is employed as a standard of comparison for evaluating the accuracy of the methods, and the comparison is quite good. Hence these techniques may be useful for solving other problems of a similar nature where exact solutions cannot be obtained. The approximate methods involve solving an eigenvalue problem by expansion in terms of orthogonal functions which are selected to automatically satisfy some of the required boundary conditions.

R. Siegel, USA

398. Drakhlin, E. Kh., The free, steady-state convection in a cavity bounded by two coaxial, horizontally-infinite cylinders (in Russian), *Uch. zap. Molotovsk. in-ta* **9,** 4, 41–47, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3182.

An approximate solution is developed for the problem of the steady-state convection in a liquid or gaseous medium filling a cylindrical gap bounded by coaxial, circular, horizontal cylinders of infinite extension, when a constant temperature gradient exists in the mass at infinity, perpendicularly to the axis of the cylinders, but not vertical. From considerations of symmetry, the problem is regarded as two-dimensional.

The equations of steady-state heat convection are solved by the method of successive approximation, founded on expansion of the solutions by powers of the Grashof number. The temperature distributions in the liquid are determined for the internal and external masses in the null and first approximations, and the distributions of the hydrodynamic velocities of the liquid in the first approximation.

S. B. Gerasimova

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

399. Martin, B. W., and Cresswell, D. J., Influence of Coriolis forces on heat transfer in the open thermosyphon, *Engineer, Lond.* **204,** 5318, 926–930, Dec. 1957.

Study is a thorough treatment of heat transfer in a simulated system of a hollow turbine blade cooled by fluid circulated by means of integrated thermosyphon. It contains sufficient background on the stipulated problem to illustrate its research value and its usefulness to practical gas turbine development. Although the apparatus used in the well-described procedure is a static one, a realistic modification of most major parameters has been made to allow for reasonable translation to gas-turbine operating conditions. There the circulatory system can be formed to operate quite effectively with the forces created by rotation in addition to those by thermosyphon. Ethylene glycol and water tests are described with the apparatus in vertical and several tilted positions up to 45°. The effects of tilting on heat transfer are shown graphically, using dimensionless parameters (Nusselt, Prandtl, and Grashof numbers). The magnitude and effects of Coriolis forces (describing combined radial and circumferential movement of fluid particles) are derived and used for correlation between the static apparatus and the anticipated conditions in a gas turbine.

C. R. Bell, USA

400. Rotem, Z., Heat transfer from rotating discs, *J. roy. aero. Soc.* **62,** 568, p. 303 (Tech. notes), Apr. 1958.

401. Glaser, P. E., and Blau, H. H., Jr., On the measurement of high temperature radiation properties of solids, ASME-ARS Joint Aviation Conf., Dallas, Texas, Mar. 1958. Pap. 58-AV-29.

The principles underlying emissivity measurements in solid materials to 3500 K, and conditions for carrying out these measurements are briefly reviewed. The advantages of using a solar furnace for this application are pointed out and the necessary optical system described. The function of the shutter for separating emitted and incident radiation, control of the temperature by the aperture limiting cylinder, and the calibration of the monochromator by a black-body reference standard are explained.

A. Whillier, South Africa

402. Brenden, B. B., Newkirk, H. W., Jr., and Woodcock, S. H., A study of temperature measurement in a solar furnace, *J. Solar Energy, Sci. and Engng.* **2,** 1, 13–17, Jan. 1958.

Authors discuss methods for accurately measuring high temperatures, using thermocouples up to 1100C, and optical methods from 1100C to 3500C. A two-color pyrometer makes readings independent of emissivity, and an additional brightness pyrometer permits measurement of emissivity at the high temperatures.

A. Whillier, South Africa

403. Chang, Y. P., Wave theory of heat transfer in film boiling, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-19, 8 pp.

Heat transfer in saturated and subcooled film boiling from horizontal and vertical surfaces is analyzed from the viewpoint of the wave theory for natural convection.

From author's summary by W. M. Rohsenow, USA

404. Zielenski, E., Film-boiling on boiler surfaces, *Combustion* **29,** 12, 47–50, June 1958.

An ingenious explanation is presented for existence of blisters due to overheating on boiler tubes. It is as follows: Scale breaks from tube wall exposing hot metal to water, temperature difference is such that film boiling exists so that tube further overheats leading to failure. Good circumstantial evidence points to such a mechanism.

W. M. Rohsenow, USA

405. Birkhoff, G., Margulies, R. S., and Horning, W. A., Spherical bubble growth, *Physics of Fluids* **1,** 3, 201–204, May–June 1958.

An understanding of bubble growth is essential to the understanding of the kinetics of phase transitions in such processes as nucleate boiling. Authors develop, without recourse to the "boundary layer" assumption, a relation for the proportionality constant in the asymptotic bubble growth law $R = K(\alpha t)^{\frac{1}{2}}$. This is helpful in the comparison of theories [AMR **7** (1954), Revs.

336, and 3362] of the rate of bubble growth in superheated liquids. Both theories are in fair agreement with experiment [AMR **7** (1954), Rev. 1961]. Authors relation includes that of Plesset and Zwick [AMR **7** (1954), Rev. 3362] as a limiting case. Authors also show that their relation is approximately applicable to bubbles in supersaturated liquids. C. E. Sanborn, USA

406. Savic, P., The cooling of a hot surface by drops boiling in contact with it, *Nat. Res. Counc. Canad., Mech. Engng. Rep.* MT-37, v + 28 pp. + 10 figs., + appendix, Apr. 1958.

A theory is developed describing the growth and subsequent collapse of a vapor bubble forming on the interface between a heated solid and a subcooled liquid. Experiments with water drops impinging on a hot silver surface suggest that nucleate boiling is responsible for the cooling process in the initial stages of the motion, but that the drop is broken up by vapor bubbles breaking through the upper (free) surface of the drop and that hereafter the heat transfer is greatly reduced by the fragments of the drop passing into the spheroidal state.

From author's summary by W. M. Rohsenow, USA

407. Dutkiewicz, R. K., Preliminary studies into boiling heat transfer, *So. African Mech. Engr.* **7,** 8, 231–246, Mar. 1958.

Mechanism of boiling is reviewed and results of author's experiments on platinum wires are presented. Burnout fluxes appear low for water, probably due to a small wire being used so that the wire size affected the results. Importance of surface condition of q/A versus (ΔT) curve is stressed. Experiments are not fundamentally different from those of Rarber and Scorah, Addoms and McAdams, or others. W. M. Rohsenow, USA

408. Nishikawa, K., Nucleate boiling heat transfer of water on the horizontal roughened surface, *Mem. Fac. Engng., Kyushu Univ.* **17,** 2, 85–103, Jan. 1958.

Water is boiled on various surfaces with regular types of roughness. Heat flux, surface temperature, bubble size, frequency, and shape are recorded. An attempt is made to correlate the data using various fluid properties and a semi-empirical analysis. A fair correlation in terms of a "coefficient of foamability" is obtained which depends on the surface condition and the fluid.

W. M. Rohsenow, USA

409. Egen, R. A., Dingee, D. A., and Chastain, J. W., Vapor formation and behavior in boiling heat transfer, ASME Ann. Meet., New York, N. Y., Dec. 1957. Pap. 57-A-74, 9 pp.

An experimental program was conducted to study the formation and distribution of vapor in a rectangular channel under boiling-heat-flux conditions at 2000 psia. In addition, the problem of preferential distributions was studied to determine its effect on the validity of the results of this program. Over the range of variables tested, there was no flow-rate effect, and the slip, where determinable, appeared to be constant. The boid fraction is correlated with the quality and heat flux, in the vicinity of zero quality; the dependence upon heat flux decreases with increasing quality in this region. Inlet-temperature variation has no effect on the value of the boid, providing the inlet temperature is below the temperature necessary for local boiling.

From authors' summary by W. M. Rohsenow, USA

410. Kobayasi, K., A study of the evaporation of a single liquid droplet, *Technol. Rep., Tohoku Univ.* **18,** 2, 209–222, 1954.

Evaporation of liquid drops has importance for spray driers, fuel sprays from carburetors, from diesel engine nozzles and from gas turbine injection systems. Basic research on this problem concerns the analysis of the evaporation of a single drop; this has been done by numerous previous investigators, among them the author, on whose previous work (Tanasawa and Kobayasi 1950) the present investigation is based. A liquid drop is suspended on a quartz filament within an electric furnace, and it is photographed through windows at definite time intervals. Various liquids were used; in particular, pure petroleum fuels and blends. Various furnace temperatures were maintained. Results are stated in tables and charts, and compared with the theoretical values, on the basis of "coefficient of evaporation velocity." Error sources of the method, in particular, those caused by the conductivity of the quartz filament, are discussed. Film strips showing the successive diminishment of the drops are included.

K. J. DeJuhasz, Germany

411. Semenovker, I. E., The origin of pulsations in the evaporator tubes of steam boilers (in Russian), "Hydrodynamics and heat exchange in boiling, in high-pressure steam generators," Moscow, Akad. Nauk SSSR, 1955, 155–172; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3204.

Results are given of experiments on the pulsations of pressure and flow in the evaporator tubes of steam boilers. The tests were made with a straight-flow boiler with repeated, forced circulation, on a special test stand. It is maintained that the appearance of flow pulsations is not associated with the forced motion of the liquid but is due to the horizontal, or nearly horizontal, arrangement of the heating surfaces. In vertical tubes pulsations do not arise, even in the most favorable conditions, e.g., removal of washers, small velocities, etc.

Flow pulsations are caused by processes taking place in the region of low steam percentages. The promoting factors of pulsation, in this region, are the reduction in the weight of flow through the tubes, increased intensity of heating, and increasing diameter of the tube.

The total length of the evaporator coil and the ultimate steam content corresponding to the ratio of length of the economiser to the steaming section do not influence the occurrence of pulsation.

Z. L. Miropol'skii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

412. Shein, V. B., Convection phenomena in the evaporation of water from vertical tubes (in Russian), *Uch. zap. Molotovsk. in-ta* **9,** 4, 85–92, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3205.

By measuring the rate of evaporation of water from the tube and the distribution of the atmospheric humidity within the same, it is demonstrated that, depending on the diameter of the tube and the water level therein, the transfer of the steam outside the tube proceeds either by diffusion or by convection.

For an explanation of the results obtained, the analogy of the investigated phenomenon is identified with the phenomenon of thermogravitational convection in a vertical tube filled with water and heated from below. The latter case has been investigated in detail by G. A. Ostorumov ["Free convection in the conditions of the internal problem," Gostekhizdat, 1952].

M. P. Sorokin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

413. Miesse, C. C., The effect of a variable evaporation rate on the ballistics of droplets, *J. Franklin Inst.* **264,** 5, 391–401, Nov. 1957.

[See AMR **9** (1956), Rev. 3770]

414. Glaser, H., Temperature and vapor pressure profiles in a homogeneous wall with moisture condensation (in German), *Kaltetechnik* **10,** 6, 174–179, 1958.

When the temperatures and water-vapor partial pressures on both sides of a homogeneous porous wall differ, heat will flow across the wall by conduction and water vapor will diffuse through the pores. If saturation is not reached anywhere in the wall, the temperature and vapor pressure profiles will be essentially straight lines. If saturation is reached in the wall, moisture will condense over part of the wall thickness. The liberation of the latent heat of condensation of the accumulating moisture will cause curvature in the temperature profile, and the disappearance of water vapor through condensation will similarly affect the vapor pressure profile.

In this second of a series of four articles on this topic, author develops a differential equation with respect to depth within the wall for the temperature and vapor pressure distributions in the condensation zone. Using a polynomial to approximate the vapor pressure curve, he eliminates partial pressure from the differential equation and integrates. The integrating constants are evaluated from the conditions at the boundary of the wall. From the temperature profile thus obtained, the vapor pressure profile is established by reference to the vapor pressure curve. The vapor pressure profile in turn may be used to determine the rate of condensate accumulation. A numerical example is evaluated to illustrate the effect of varying vapor diffusivity on the condensate rate and the width and location of the condensation zone in the wall. Author indicates that the assumption of constant vapor diffusivity and thermal conductivity over the entire wall thickness is valid only when the condensate in the wall fills a small fraction of the pore volume. Moisture diffusion by capillary forces and the effect of liquid film curvature on the saturation vapor pressure are neglected.

An important application of this analysis is the prediction of condensation and freezing in thermal insulation and in masonry and concrete walls. It might have been helpful if the vapor diffusivities and thermal conductivities of some representative building and insulating materials had been listed.

A. W. Gessner, USA

415. Dabora, E. K., Regenerative heat exchangers with heat-loss consideration, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-29, 20 pp.

The differential equations describing the regenerative-type heat exchanger with heat-loss consideration are solved by using Laplace transform, the solution being simplified by the assumption that the over-all heat-transfer coefficient to the surroundings is constant. The solution is carried out for two cases: (a) Heating the bed from a uniform initial temperature equal to that of the surroundings with fluid at constant inlet temperature, and (b) cooling the bed from a uniform temperature with fluid at constant inlet temperature equal to that of the surroundings. Typical curves of the transient bed temperature are included for both cases. The steady-state temperature which the bed attains on heating is shown to depend solely on the ratio of the heat loss to the fluid heat capacity; therefore, for any heat-exchanger design where the maximum temperature that can be attained at the exit is of importance, this term should be estimated carefully.

From author's summary by G. G. Thurlow, England

416. McLean, E. A., Scherrer, V. E., Nanney, C. A., and Faneuff, C. E., Interferometer used to study transient heating of water, *Rev. sci. Instrum.* **29,** 3, 225–228, Mar. 1958.

Paper describes a Mach-Zehnder interferometer used to study heat transfer in water. The equation is derived relating temperature change to fringe shift and a correction procedure is given for end effects. The method is used to determine temperature distributions for pulse-heated nichrome foils in water: distributions at a given time (100 msec after heating pulse) for three different pulse energies (0.375, 0.64, 0.90 watt-sec); distributions for a given pulse energy (0.90 watt-sec) at three different times (100, 200, 400 msec). A temperature gradient of 280C/cm can be resolved with the experimental conditions, but this gradient is not the highest obtainable using this technique.

E. A. Brun, France

417. Tchucklin, S. G., The dynamics of the processes of heat and humidity exchange in refrigerator cold chambers (in Russian), *Trudi Odessk. tekhnol. in-ta pishchev. i kholodiln. prom-sti* **6,** 132–145, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3175.

The usual formulation of the problem of heat and humidity exchange between the air and the cooled surface is complicated by the introduction of hoar frost forming on the cooling surface. Formulas are presented for the time precipitation and maximum thickness of formation of hoar frost on a pipe and on a flat plate. A method is indicated for calculating the temperature and relative humidity of the atmosphere in a cold chamber, degree of dehydration of the stored products, and the other parameters of the process, on a time basis. A numerical example is appended.

V. S. Zhukovskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

418. Gobza, R. N., The results of full-scale investigations of heating systems with a concentrated air outlet (in Russian), *Trudi nauch. sessiyi Vses. n.-i. in-ta okhrany truda,* no. 4, 83–106, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3198.

Combustion

(See also Revs. 317, 410, 501, 534)

419. Emmons, H. W., Theoretical aerothermodynamics, Heat Transf. and Fluid Mech. Inst., Univ. of Calif., Berkeley, Calif., June 1958, 1–14.

The general equations of aerothermodynamics are presented and several problems, the flow through a nozzle and the film combustion of evaporable fuel, are solved. The possibility of greatly increasing our understanding of aerothermodynamic problems by systematic work with simplified chemistry is thus illustrated.

The derivation of the over-all conservation equations from continuum theory, and the definition of the diffusion stress tensor, require careful analysis. A consistent treatment is given in Emmons' reference 3 but not in his reference 2.

S. S. Penner, USA

Book—420. Penner, S. S., Chemistry problems in jet propulsion, London, Pergamon Press, Ltd., 1957, xiv + 394 pp. $12.50.

In this space age, the objects of yesterday's research programs are frequently tools for today's research or development programs, and a typical research or development program is more likely to be conducted by a team of engineers, physicists, and mathematicians than by a lone scientist. This situation places added obligations upon writers of text reference books—obligations discharged well in this recent contribution from the Guggenheim Jet Propulsion Center at the California Institute of Technology.

Contents are divided into three parts: I. Atomic and molecular structure; II. Combustion thermodynamics; and III. Combustion. Part I deals (sometimes in a survey fashion) with atomic structure, wave mechanics, polyelectronic atoms, formation of molecules and chemical bonds, molecular vibrations, standard heats of formation and bond energies, and chemical compounds used as propellants. Part II handles mathematical preliminaries, the first law of thermodynamics, the second law of thermodynamics, heat capacities and

heats of reaction, criteria for equilibrium, Bridgman tables, calculation of adiabatic flame temperatures and equilibrium compositions, performance of chemical propellants for rocket engines, free energy and phase equilibria, real gases, and theoretical calculation of thermodynamic functions for ideal gases. The last part treats classical (phenomenological) chemical kinetics, conservation of mass, momentum, and energy in reacting mixtures, transport properties of gases, heterogeneous chemical reactions, detonation and deflagration, the (Rankine-) Hugoniot curve, diffusion flames, chemical reactions during adiabatic expansion through a de Laval nozzle, laminar flame propagation in premixed gases, similitude considerations for a number of combustion problems, and combustion processes in liquid-fuel rocket engines.

Author uses book as text for one-year graduate course in jet-propulsion chemistry. Reviewer has used book as text for one-semester graduate course in aerothermochemistry, omitting portions of book but adding material on (a) derivation of equations describing conservation of mass, momentum, and energy in reacting mixtures, (b) elementary kinetic theory of gases, and (c) irreversible thermodynamics. Reviewer plans to add also material on law of corresponding states in future offerings of course.

Reviewer has relatively few criticisms of book, but does feel that the material would be transmitted more clearly and the reader's interest stimulated if the mathematical analyses were supplemented more frequently with detailed descriptions of physical models and processes. Text is relatively free of typographical errors.

Treatments of the diffusion stress tensor by several authors have led to apparently conflicting results. Results of kinetic theory indicate that the first-order expression for the stress tensor does not contain contributions due to diffusion [Hirschfelder, J. O., Curtiss, C. F., and Bird, R. B., "The molecular theory of gases and liquids," John Wiley and Sons, Inc., New York 1954; AMR **8** (1955), Rev. 496]. Results of a theory based on the idea of a multicomponent continuum composed of coexistent continua indicate that the stress tensor does contain contributions due to diffusion [Penner, p. 239]. It appears to the reviewer that the diffusion stress tensor is a second-order term and that no conflict exists if only first-order terms are retained in each derivation.

Reviewer considers this timely book to be the best available text for graduate courses in combustion and propulsion chemistry, and recommends it as a valuable asset to the graduate engineer interested in performance and scaling of air-burning and rocket engines, as well as to the scientist investigating chemical reactions in flow systems. E. L. Knuth, USA

421. Moutet, H., Moutet, A., and Barrere, M., Influence of temperature and pressure on the ignition delays of hypergolic fluids (in French), *ONERA NT* 45, 22 pp., 1958.

Article presents ignition delay data obtained under ignition conditions similar to those encountered in rocket combustion chambers at high altitude. Research equipment is described and the effects of pressure and temperature are studied separately. Xylidine, triethylamine and furfural alcohol are studied as pure substances and mixtures. The shortest ignition delays (9 milliseconds) were obtained with a mixture of xylidine and furfural alcohol. The evolution of the chemical reactions preceding ignition are analyzed. R. A. Gross, USA

422. Dalmai, Gisele, Investigations on the inflammability ranges of methane-air and butane-air mixtures ignited by electric sparks, *Combustion and Flame* **2,** 2, 171-180, June 1958.

A tentative explanation of the two-lobed shape of the inflammability ranges of a number of hydrocarbons is given in terms of the following sets of phenomena: (1) The apex lying between the two lobes is conditioned by flame quenching mainly caused by vibrations of the flame propagating inside a close tube; (2) the "second region" of the inflammability range is due to preferential diffusion of the deficient component of greater diffusivity. This causes a shifting of the mixture composition and leads to the propagation of small axial flames. This phenomenon occurs for mixtures richer than those determining the passage from one lobe to the other. At these concentrations the mixtures are considered "at the limit." From author's summary

423. Evans, Marjorie W., Given, F. I., and Muller, G. M., Ignition of electrolytic monopropellants by submerged electrical discharge, *Jet Propulsion* **28,** 4, 255-256, April 1958.

424. Bollinger, L. E., Evaluation of flame stability at high Reynolds numbers, *Jet Propulsion* **28,** 5, 334-335, May 1958.

Velocity gradients and thickness of the laminar sublayer boundary layer are determined for flame stability at high Reynolds numbers. These are computed by using the empirical formula of Prandtl and Lees for friction factor with turbulent flow and then applied in the general equation for velocity gradients and boundary-layer thickness. A. S. Andes, USA

425. Seifferlein, Th., On the flame stability at burners of aircraft jet engines (in German), *Forsch. Geb. Ing.-Wes. Dusseldorf* **24,** 1, 15-18, 1958.

The use of flame holders to maintain stable flames in combustion chambers of high-speed jet aircraft is examined. From aerodynamic, thermodynamic, and reaction kinetic considerations author derives a general condition for stability. Relationships between variables are shown graphically and the form of these relationships is compared with previously known empirical expressions. Further work is required to establish formulas which can be of practical use. M. F. Hoare, England

426. Wells, R. A., High-energy fuels for aviation, *Mech. Engng., N. Y.* **80,** 9, 55-59, Sept. 1958.

An introduction to high-energy fuels discusses four types and their performance when applied to their intended aviation power plants. Paper also includes state-of-the-art summary. From author's summary

427. Gilbert, M., The hydrazine flame, *Combustion and Flame* **2,** 2, 137-148, June 1958.

Experimental data on the hydrazine flame speed are pressure-independent at low pressures. Thus, a second-order reaction mechanism is assumed to be controlling. Kinetics are given for a chain mechanism in which the NH_2 radical is formed by a pseudo-unimolecular process, tending to first order at high pressures, but second order at low pressures. The consequent set of flame equations can be solved using the chemical steady-state hypothesis. In this instance, however, the solution to the flame equation leaves both the flame speed and the over-all chemical rate constant undetermined for the hydrazine decomposition. By inserting the experimental flame speed, a value for this rate constant is obtained. It is also possible to calculate the second-order rate constant for the formation of activated N_2H_4 radicals. The rate $k_a \simeq 3 \times 10^{14} \exp(-60\,000/RT)$ cm³/mole sec. The unusually high value for this constant suggests energy transfer to the N-N bond from many vibrational modes of N_2H_4. Re-examination of earlier data of Szwarc on the formation of NH_2 radicals treated as a first-order process indicates that a second-order may be implied from the data and, also, a value for $k_a \simeq 10^{19} \exp(-60\,000/RT)$ cm³/mole sec may be deduced. Investigation of the validity of the chemical steady state for free radicals in the hydrazine flame is made. It is determined that the flame may only be roughly approximated by the chemical steady state. From author's summary

428. Gilbert, M., Kinetics of hydrazine decomposition in a laminar non-isothermal flow, *Combustion and Flame* **2,** 2, 149–156, June 1958.

The experimental results on the decomposition of hydrazine are re-examined. The assumption is made that a dilute hydrazine-toluene gas mixture at low pressure will not undergo isothermal reaction under the flow conditions experienced in the apparatus used by Szwarc, but that there will be a strong effect due to heat transfer in the entrance region of the reactor. Analysis of the nonisothermal reactor leads to reinterpretation of the experimental rate data. The existing data are found to favor a second-order formation for NH_2 radicals, rather than a first-order formation. The rate constant is approximately 10^{19} exp $(-\ 60\ 000/RT)$ cm^3/mole sec, which appears to be the low-pressure value in a quasi-unimolecular rate process.

From author's summary

429. Mertens, J., and Potter, R. L., Gaseous nitric acid-hydrocarbon flames, *Combustion and Flame* **2,** 2, 181–192, June 1958.

Burning velocities of gaseous nitric acid and four hydrocarbons, propane, *n*-heptane, methyl*cyclo*pentane, and toluene have been measured at atmospheric pressure. Burning velocities of nitric acid-propane flames also have been measured at a half and two atmospheres. Flame temperature measurements and spectroscopic observations have been made for some of these flames. The appearance of these flames is similar to hydrocarbon flames burning with nitrogen dioxide; however, the second combustion wave does not appear unless piloted by secondary air when the temperature of the combustible mixture is 400 K. When the temperature of the combustible mixture is raised so that the final adiabatic flame temperature approaches 3000 K, reactions downstream of the first combustion wave are speeded up sufficiently to produce a new combustion wave in the absence of secondary air.

From authors' summary

430. Minkoff, G. J., Some recent developments concerning free radicals (a review), *Combustion and Flame* **2,** 2, 193–207, June 1958.

431. Dumortier, J., Study of the combustion of traces of CO capable of producing increased transfer in contact with steel walls. Parts I, II, (in French), *Flamme et Thermique* **10,** 116, 13–24, 33–37, May 1958; **10,** 117, 33–45, June 1958.

Flows containing small amounts of CO in dry air are passed through glass and silica tubes containing mild-steel or chrome-steel packing. Tubes are heated by a furnace permitting arbitrary time-temperature programs. Results of chemical analysis indicate that some surface reactions occur in the temperature range 150–650C. Mild steel has greater catalytic effect. Author discusses possible effects of such reactions in increasing transfer in practical machinery in contact with hot exhaust gas, e.g., the action on the blades of a gas turbine. M. Gilbert, USA

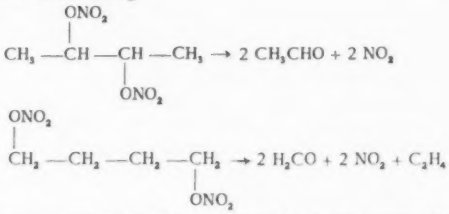
432. Wilde, K. A., Effect of radical recombination kinetics on specific impulse of high temperature systems, *Jet Propulsion* **28,** 2, 119–120, Feb. 1958.

433. Yokley, C. R., and Ferguson, R. E., Separation of the products of cool flame oxidation of propane, *Combustion and Flame* **2,** 2, 117–128, June 1958.

The techniques of gas chromatography and low temperature, low pressure distillation have been applied to the problem of the separation and isolation of the major products of cool flame oxidation of propane. The methods described are adequate for separating and handling the reaction products in small amounts without appreciable contamination. Data on column performance are presented. From authors' summary

434. Powling, J., and Smith, W. A. W., The combustion of the butane-2,3- and 1,4-diol dinitrates and some aldehyde-nitrogen dioxide mixtures, *Combustion and Flame* **2,** 2, 157–170, June 1958.

Decomposition flames of butane-2,3-diol dinitrate and butane-1,4-diol dinitrate have been studied at atmospheric pressure by stabilizing flat flames upon the liquid surfaces and measuring product concentrations and temperature profiles. Products were generally analyzed by infrared methods, and an *in situ* spectroscopic method in the visible region has been employed to estimate the significant nitrogen dioxide concentrations in the flames. The results indicate that these esters, in contrast to those mononitrates so far studied, break down in a unimolecular fashion, over-all reactions being



Brief examinations of the flames of acetaldehyde-nitrogen dioxide mixtures and formaldehyde-nitrogen dioxide-ethylene mixtures have been made for comparison with those of the nitric esters, to which, in fact, they show a great similarity.

From authors' summary

435. Williams, F., and Fuhs, A. E., Apparent emission intensities from a turbulent flame composed of wrinkled laminar flames, *Jet Propulsion* **27,** 10, 1099–1102, Oct. 1957.

This paper is a mathematical treatment of the wrinkled flame front theory for turbulent flames. A model of radical and product concentration in a steady-state laminar flame is assumed. This model is extended to turbulent flames according to the wrinkled flame front theory. A probability function $p(x)$ is assigned to the turbulent flame in such a way that $p(x)\,dx$ is the probability that the center of the oscillating laminar flame will be found at a position x in the range dx in the turbulent flame zone. The emission intensity which would be observed by the use of finite slit width in a spectrographic observation is predicted. The prediction is that the product concentration (and also the average temperature) reaches half its maximum value at the center of the turbulent flame zone. Also it is predicted that a separation of $\frac{1}{2}$ to $\frac{1}{10}$ of the turbulent flame width should be observed between the onset of emission of radicals and products, as has been observed experimentally by Sommerfield and collaborators. There appears to be some confusion here since earlier in the paper the authors state that the experiments of Summerfield seem to indicate that the onset of product emission lags the onset of radical emission by more than a laminar flame width. J. T. Agnew, USA

436. Temkin, A. G., and Fedorov, V. N., The calculation of the heat exchange in a firebox (in Russian), *Teploenergetika* no. 4, 21–22, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3213.

The problem is discussed of the methods of determining the effective radiation-absorbing surface H in screened fireboxes. It is observed that the calculation method adopted in the tentative standard for the heat analysis of a boiler unit is inconvenient, since the starting formula for H incorporates the degree of blackness of the firebox, which is an indeterminate function of H; and, consequently, the problem has to be solved by the method of successive approximation. A method is suggested for the direct determination of H, founded on the use of a novel expression for the degree of screening of the firebox. A. A. Gukhman

Courtesy of Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

437. Richmond, J. K., Donaldson, W. F., Burgess, D. S., and Gumer, J., Evidence for the wrinkled continuous laminar wave concept of turbulent burning, *Jet Propulsion* **28,** 6, 393–399, June 1958.

Piloted burner flames of natural gas-air mixtures were investigated by means of flame radiation photometer measurements. Emission from the CH radical, the continuum from CO combustion, and the C — C radical was studied for time-average values and transient fluctuations of light intensity. Flow conditions ranged from 4000 to 160,000 Reynolds number and from 1 to 2% pipe-flow turbulence to 3 to 6% grid-induced turbulence. For well-piloted flames, a continuously connected flame front was indicated; for inadequately piloted flames, "holes" or breaks in the flame were indicated. Electronic probe and smoke photography experiments corroborated the existence of a wrinkled continuous laminar combustion wave in turbulent flames under restricted conditions.

Reviewer believes these experiments to be the best to date for distinguishing between flame structure models: wrinkled continuous laminar flame, distributed reaction zone, or disconnected flamelets. However he notes the authors' implication that gaps in the flame wave of less than 0.002-inch would probably remain undetected because of instrumentation limitation.

J. M. Singer, USA

438. Uberoi, M. S., Kuethe, A. M., and Menkes, H. R., Flow field of a Bunsen flame, *Physics of Fluids* **1,** 2, 150–158, Mar.-Apr. 1958.

The flow field of a two-dimensional Bunsen flame is examined by approximating the zone of combustion by a surface of discontinuity. The flow of the burned gases is always rotational and is therefore not amenable to complete analysis. Interaction of flame shape and flow field is obtained analytically and experimentally. The entire flow field of unburned and burned gases is mapped by taking stroboscopic photographs of small particles suspended in the combustible gases. The measured flow field is considered in the light of the above analysis.

From authors' summary by S. I. Pai, USA

439. Levin, A. M., Analysis and design of injection-type burners for industrial furnaces (in Russian), *Trudī in-ta ispol'zovaniya gaza Akad. Nauk SSSR* no. 3, 67–101, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2923.

A hydraulic method is presented for calculating an ejector with a cylindrical mixing chamber and subsonic gas flow velocities.

The results given of an experimental investigation of an injector-type gas burner agree well with the calculated values. To facilitate calculation according to the equations of ejection a nomogram has been drawn up for a burner working on a mixture of natural gas and air.

Yu. A. Lashkov

Courtesy of Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

440. Nechayev, V. D., Method of calculating jet-type oxyacetylene welding torches (in Russian), *Svarochnoye proiz-vo* no. 9, 13–16, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2922.

441. Kondak, M. A., and Sigal, I. Ya., An investigation of multi-jet gas burners with flame-grid attachment (in Russian), *Izv. Kievsk. politekhn. in-ta* **18,** 293–309, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2929.

Multijet gas burners with a flame grid attachment are intended for boiler and water-heating installations. The combustion air is injected into the furnace by a stream of combustible gas issuing from the burner nozzles. To stabilize the flame, the jets are shrouded in a wire-mesh attachment with 1.8-mm meshes, sufficiently narrow to prevent blow-back of the flame. Tests of this burner showed that it works sufficiently steadily, without blow-back or interruption of the flame, at gas pressures between 5 and 3,000-mm water column. In the absence of separate cooling of the attachment it is best to work with a gas pressure of the order of 20–100-mm water column, and with a coefficient of primary air excess of the order of 0–0.85. A form of construction is described enabling the over-all dimensions of the burner to be reduced.

S. M. Il'yashenko

Courtesy of Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

442. Kobayasi, K., An experimental study on the combustion of a single fuel droplet, *Technol. Rep. Tohoku Univ.* **18,** 2, 223–234, 1954.

The basis for combustion research in diesel engines and gas turbines is the combustion of a single fuel drop. Previous investigators in this field were Spalding, Godsave, Kumagai and others. Based on previous research by author on the evaporation of a single drop (Kobayasi 1954) the present work deals with the combustion of a single fuel drop, suspended on a quartz filament, photographed at timed intervals. Charts are shown giving the diminishing diameters of the drop as a function of time, for various pure hydrocarbon fuels and for commercial gasolines and heavy oils. The concept "coefficient of combustion velocity" is introduced and used as a characteristic of the various fuels. Several film strips showing the combustion of various kinds of fuel drops are reproduced. Some photos show splashes and frothings of the burning drop.

K. J. DeJuhasz, Germany

443. Poulston, B. V., and Shepheard, E. R., Fuel distribution in the combustion zone of a gas turbine combustion chamber, Shell Res. Ltd. Rep. M.179, 35 pp. + 22 figs. + 7 ref., July 1957.

Object was to examine the effect of changes in the combustion chamber configuration and air flow distribution on the fuel distribution in the combustion zone of a gas-turbine combustion chamber with a swirler-shroud-type stabilizer, in order to be able to interpret logically the combustion results. Apparatus and technique were developed for measuring the volume distribution of fuel across any diameter in the combustion zone of a model combustion chamber with the combustion air flowing in the chamber. Work was confined to studies of a swirler-shroud type of air director at atmospheric air pressure only. Effect of shroud air alone on the fuel spray was studied using different relative positions of shroud and atomizer, different spray cone angles, fuel pressures and shroud air velocities. With both shroud and swirler air flows in use, the following factors were studied: (a) shroud air flow, (b) swirler air flow, (c) swirler blade angle, (d) swirling shroud air, (e) atomizer cone angle, (f) fuel pressure, (g) length of draught tube, (h) variation of fuel distribution with distance from atomizer. These effects are shown in charts. Experimental set-up is illustrated and explained in detail.

Significance and interpretation of results can be assessed only at a later date when results from corresponding combustion tests will be available.

K. J. DeJuhasz, Germany

444. Khovakh, M. S., Investigation of the working process of an engine with a divided swirl combustion chamber (in Russian), *Trudī Mosk. avtomotn-dor. in-ta* no. 17, 25–50, 1955; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 383.

Results are given of the experimental investigation of the working process in an engine with a divided combustion chamber and an arranged swirl movement during compression. Diminishing the volume of the swirl chamber and the creation of a supplementary turbulence change in the space above the piston results in an improvement in the work of the engine.

I. S. Simonov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

445. Pchelkin, Yu. M., An investigation of the combustion chamber of a solid-fuel-fired gas turbine (in Russian), *Sb. statey Mosk. vyssb. tekhn. uch.-shcha* **39,** 67–80, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2920.

The motion of the flow in a cylindrical combustion tube is investigated; the requisite length of the tube is determined from the data of other authors concerning the duration of combustion of particles of a solid fuel. I. S. Simonov

Courtesy of Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

446. Rabinovich, D. I., An investigation of the aerodynamics of a combustion chamber on the principle of similarity (theory of dust-laden flows) (in Russian), *Nauch. zap. Odessk. politekhn. in-ta* **3,** 3–18, 1955; *Ref. Zh. Mekh.* no. 3, 1957; Rev. 2928.

Problems of the aerodynamics of a combustion chamber are examined as well as of the separation and transportation of small particles of the fuel. From the system of differential equations characteristic for the problem, similarity considerations are developed, enabling calculation of an aerodynamic model of a particular combustion chamber.

The experimental data obtained for such a model are presented, showing the weight values of the fuel carried off and leading the author to develop certain practical conclusions and recommendations.

The influence of sharp air blast on the transportation of different fractions in the model is also investigated.

O. V. Yakovlevskii

Courtesy of Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

447. Pischanenko, V. V., Features of mixture formation in the cylinder of a low-speed marine engine of great power (in Russian), *Nauch. tr. Odessk. vyssb. morekhod. uch.-shcha* no. 1, 89–100, 1955; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1829.

This is the first of a series of articles being reviewed which deal with the analysis of problems connected with the construction and operation of systems of mixture formation with the compelled disturbed flow in single-chamber engines with a large diameter cylinder. The conditions of combustion in the currents are analyzed. The author deduces that from the existing methods of mixture formation for engines of great power the only one applicable is the current-forming combined with an intensive and regularly organized vortex formation. V. N. Gusev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

448. Brobeck, W. M., Clemensen, R. E., and Voreck, W. E., A recording sodium-line reversal pyrometer, *Jet Propulsion* **28,** 4, 249–251, Apr. 1958.

A self-balancing, recording instrument for measuring flame temperatures from 1500C to 2700C is described. Radiation from sodium D lines in the flame is compared with that from a filament, and filament current is adjusted by the instrument to provide a continuous balance. Response is 50C per second, and high accuracy is claimed. H. R. Hazard, USA

Prime Movers and Propulsion Devices

(See also Revs. 163, 410, 420, 421, 425, 426, 427, 428, 442, 445, 447, 500, 505, 506, 507, 535, 536, 537, 592)

449. Semeka, V. A., Determination of the amount of heat return (in Russian), *Trudi Cent. n.-i. in-ta mor. flota* **1,** 2, 3–8, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2951.

Noting the deficiencies of existing methods for determining the amount of returned heat in the process of steam expansion in a multistage turbine, author suggests a more convenient method of calculation. From an analysis of the expansion process in the presence of internal losses, the *T-S* diagram is used to derive an expression for the elementary increase of the available adiabatic gradient of heat; after summation, the total value of the heat returned to the cycle is obtained. L. I. Kiselev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

450. Hussmann, A. W., and Pullman, W. A., Pressure fluctuations in multi-cylinder exhaust manifolds, ASME Ann. Meet., New York, N. Y., Dec. 1957. Pap. 57-A-196, 13 pp.

Paper deals with the influence of pressure fluctuations in the exhaust manifold of a multicylinder engine upon the amount of air flow through the cylinders. By analogy with torsional crankshaft vibrations a method is developed by which the pressure fluctuations at any point in the manifold can be predicted qualitatively for any system, for different firing orders and operating conditions, and for speeds near resonance conditions. Experimental data in support of the theory are presented in the form of indicator diagrams and individual flow measurements.

From authors' summary

451. Miller, R. H., A low-temperature supercharging system for compression, pilot-oil and spark-ignition engines, ASME Ann. Meet., New York, N. Y., Dec. 1957. Pap. 57-A-250.

For more than 50 years the diesel cycle held the position of prime mover having the highest thermal efficiency. In 1951 this position of supremacy was lost to the Atkinson spark-ignition "perfect-cycle" low-temperature supercharged gas engine, in which indicated thermal efficiency of 50%, based on LHV, was attained at 210 psi, mean indicated pressure. As described in the paper a low-temperature supercharged dual-fuel engine using pilot oil for ignition of the air-gas mixture operates with the same high thermal efficiency. From author's summary

452. Benson, R. S., The effect of variation in cylinder length on the exhaust port timing of a two-stroke cycle engine, *J. roy. aero. Soc.* **62,** 569, 382–384 (Tech. Notes), May 1958.

453. Kruglov, M. G., Influence of an irregular flow of gases on the process of gas exchange in a two-stroke engine (in Russian), Dvigateli vnutrennogo sgoraniya, Moscow, Mashgiz, 1955, 64–79; *Ref. Zh. Mekh.* no. 2, 1957, Rev. 1831.

Author states that, when calculating the processes of gas exchange in a two-stroke engine to determine the pressures of gases in the cylinder of the engine, the simplified formulas put forward by him can be used in a number of cases.

V. P. Abrukov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

454. Leonkov, A. M., Effect of axial clearance and overlap on the loss of energy in the turbine stage (in Russian), *Sb. nauch. rabot Belorus. politekhn. in-ta* no. 53, 88–107, 1956; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 361.

Results are produced of the experimental investigation of the flow in the axial clearance of a turbine stage and loss therein, with reference to the size of the axial clearance and overlap between the edges of the jet and working blades. The investigation was made on an immovable flat cascade, fitted with special apparatus to imitate those flows which are met within the actual stage, and also in the model of a turbine stage. Experiments have shown that in consequence of the ejection action of the flow in the axial clearance there is a marked increase in energy loss in the end sections of the blades. The scouring of the flow takes place not only in the region of overlap but spreads to a definite height of the blade. Increase of overlap leads to a larger scouring

of the flow and growth of the losses. At the same time, the cutting off of part of the flow when overlap equals zero does not result in a significant diminution of the power of the turbine, because the part of the flow cut off, which takes its place in the working cycle with a large angle of attack, is the part of least value. Unsatisfactory conditions of boundary flow of the working blades in the region of overlap can significantly lower the efficiency of the turbine, more especially when the turbine blades are short. Increase in the axial clearance leads to the increase in that part of the blade within which the scouring of the original flow takes place. Author comes to the conclusion that in stages with small axial clearances overlap should be avoided and small overlaps should be used only in stages having large axial clearances. In order to reduce the losses which have been investigated, a recommendation is made to use a packing collar inserted next to the rotor disk. The tests on the model turbine generally confirmed the results obtained on the flat cascade.

V. Kh. Abiants
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

455. Howard, C., Jr., and Hendrickson, R. L., The use of adjustable-stator blades to reduce the idle fuel flow of a simple cycle, single-shaft gas turbine, ASME Gas Turbine Power Conf., Washington, D. C., Mar. 1958. Pap. 58-GTP-5, 6 pp.

A simple-cycle, single-shaft, gas-turbine power plant has been tested with adjustable compressor-stator blading to investigate this method of reducing idle fuel flow. This paper discusses the factors affecting idle fuel flow, and presents results of power-plant tests with several stator geometries.

From authors' summary

Book—456. Kazandjan, P. K., Alexeev, L. P., Govorov, A. N., Konovalov, N. E., Nechayev, Yu. N., Pavlenko, V. F., and Fedorov, R. M., Theory of jet engines (in Russian), Moscow, Voyenizdat, 1955, 296 pp. + illus.; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 2994.

This compendium contains 20 articles devoted to the operation of jet engines and bladed turbines. A particularly careful analysis is made of the problems of thermodynamics and gas dynamics in the operation of turbojet and turboprop engines: working of the centrifugal and axial compressor, engine characteristics, supercharging problems, etc. The combustion process is dealt with schematically. G. A. Varshavskii
Courtesy of Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

457. Charwat, A. F., Thermopropulsive characteristics of high speed thrust generators, *Aero/Space Engng.* **17,** 6, 49–55, June 1958.

A review of the fundamental propulsive and thermodynamic properties of aircraft power plants with particular emphasis on their high-speed potential. From author's summary

458. Ashwood, P. F., and Higgins, D. G., The influence of design pressure ratio and divergence angle on the thrust of convergent-divergent propelling nozzles, *Aero. Res. Counc. Lond. curr. Pap.* 325, 15 pp. + 16 figs., 1957.

Tests have been made to determine the thrusts obtainable from two groups of Laval-type convergent-divergent propelling nozzles over a range of pressure ratios up to 9 : 1 using air at sensibly ambient temperature. The nozzles of the first group were designed for pressure ratios of 4, 6, 8, 10 and 12 and had an included divergence angle of 20°, while those of the second group were all designed for a pressure ratio of 8 and had included divergence angles of 5°, 10°, 20°, 30° and 50°.

The superior thrust performance at high pressure ratios of the Laval-type nozzles over that of a plain convergent nozzle has been demonstrated. The effect of divergence angle on the thrust has been examined and, within the range 5° to 25°, been found to be small.

A comparison between the performance of a Busemann-type profiled nozzle designed to give parallel flow at outlet and an equivalent nozzle having a straight conical divergence has shown that at the design point the profiled nozzle gives about 2% more thrust.

All the nozzles tested, with the exception of one having 5° divergence angle, exhibited a form of jet instability at very low pressure ratios. The conditions under which this occurs are presented graphically. From authors' summary

459. Macioce, E., Liquid propellants for rocket engines (in Italian), *Aerotecnica* **38,** 1, 44–47, Feb. 1958.

The requirements for liquid propellants for rocket engines, from various points of view, are briefly considered. Information on the future developments of chemical propellants is given.

From author's summary

460. Roy, M., Supersonic jet propulsion (in French), *ONERA NT* 42, 38 pp., 1958.

The general parameters by which air-breathing supersonic jet-propelled aircraft or other air vehicles may be systematically analyzed are presented in the form of diagrams derived from the basic equations. The evaluation techniques should serve as a worthwhile convenience. J. F. Lee, USA

461. Probert, R. P., Ram-jets, *J. roy. aero. Soc.* **62,** 567, 151–173, Mar. 1958.

462. Smith, E. T. B., Solid propellant rocket motors, *J. Brit. interplanetary Soc.* **16,** 4, 198–211, Oct./Dec. 1957.

463. Geckler, R. D., and Davis, R. E., Modern developments in solid-propellant rocket engineering, *Aero. Engng. Rev.* **16,** 8, 42–46, 51, Aug. 1957.

Magnetohydrodynamics

464. Landshoff, R. K., Magnetohydrodynamics, Heat Transf. and Fluid Mech. Inst., Univ. of Calif., Berkeley, Calif., June 1958, 253–263.

A clear although brief review. Starting with a discussion on the characteristic lengths of plasma and the magnetohydrodynamic equations, paper goes on to survey recent work on astrophysics, generation of high-speed plasma, and thermonuclear work. The more "practical" problem of the effect of magnetic fields on heat transfer and drag, a problem probably of most interest to aeronautical engineers, was mentioned in only one sentence. A list of 21 references covers a wide range of different aspects of magnetohydrodynamics. H. Yeh, USA

465. Magnetohydrodynamics—A seminar, *J. Sci. Indust. Res. India* **17A,** 5, 194–196, May 1958.

466. Kaufman, A. N., Effect of charge separation on plasma diffusion in a strong magnetic field, *Physics of Fluids* **1,** 3, p. 252, May-June 1958.

A brief analysis is presented to test the assumption that in a low-density fully ionized plasma, confined by a magnetic field, the effects of charge separation on the plasma diffusion are negligible. The results show that the induced field satisfies a diffusion-like equation and, to the order of the approximation, becomes constant after a finite time. The value of this induced field is proportional to not only the total charge at the point, but also to the fractional change in the number of particles over a Debye radius. When this charge separation field is constant the diffusion flux of ions van-

ishes. By accounting for ion-electron collisions as well as electron-electron collisions it is found that the effects of charge separation are small and the standard assumption is valid.

The practical consequence of the analysis discussed above is to affirm the generalizations that are based upon the customary assumptions in plasma analysis. E. E. Covert, USA

467. Ziemer, R. W., and Bush, W. B., Magnetic field effects on bow shock stand-off distance, *Phys. Rev. Letters* **1,** 2, 58–59, July 1958.

This note reports a comparison between some measurements on the displacement of a bow shock from a hemisphere and the calculated displacement. The calculations were based on a simplified model which consisted of an incompressible, inviscid isothermal fluid layer between the hemisphere and assumed hemispherical shock. The magnetic field was that of a dipole at the origin of the hemisphere. The dipole axis was parallel to the stream velocity ahead of the normal shock. The experimental results are presented as the fractional increase on the shock standoff distance as a function of a nondimensional parameter which is just the ratio of the square of the Hartmann number to the Reynolds number. Consequently this parameter is proportional to the ratio of magnetic stress to dynamic fluid stress.

The comparison of the theory with experiment is good at low values of the magnetic stress but the theory tends to systemmatically overestimate the shock displacement when the magnetic stresses are much larger than the dynamic stresses.

In the opinion of the reviewer, the simplifications that have been introduced into the theoretical model contain several compensating factors. The data presented should be extremely valuable in studying the effects of the several assumptions. It does seem quite likely that if a more accurate representation of Ohm's law were used the agreement between calculation and measurement would be improved. It can be shown that the ion slip and Hall currents have the effect of reducing the effectiveness of the magnetic field in a manner that the data seems to follow.

E. E. Covert, USA

468. Bader, M., and Carlson, W. C. A., Measurement of the effect of an axial magnetic field on the Reynolds number of transition in mercury flowing through a glass tube, *NACA TN* 4274, 5 pp. + 3 figs., May 1958.

Experiments were conducted to determine the effect of a 15,000 gauss axial magnetic field on the flow of mercury through a glass tube of 0.027-inch inside diameter. It was found that when only slight instabilities were present at Reynolds numbers from 5000 to 8000, the Reynolds number of transition could be increased by as much as 10%. From authors' summary

469. Eskinazi, S., Turbulence measurement in electrically conducting fluids, *Physics of Fluids* **1,** 2, 161–162, Mar.-Apr. 1958.

470. Neuringer, J. L., and McIlroy, W., Incompressible two-dimensional stagnation-point flow of an electrically conducting viscous fluid in the presence of a magnetic field, *J. aero. Sci.* **25,** 3, 194–198, Mar. 1958.

When a blunt body moves through the atmosphere at high hypersonic speeds there exists a cap of ionized gas between the detached shock and the nose of the body. It was considered possible that, by impressing a magnetic field out of the nose of the body and into the conducting gas, some beneficial effects could be derived from this region. In order to demonstrate this fact theoretically, consideration was given to the well-known problem of the two-dimensional stagnation-point flow on an infinite flat plate, modified in two ways: (1) the fluid was assumed incompressible but conducting, and (2) impressed on the fluid was an external parallel magnetic field normal to the plate. From the resulting analysis of the hydromagnetic interaction, it appears that a considerable reduction in skin friction may be possible with reasonable values of the applied magnetic intensity and electrical conductivity of the fluid.

The reduction in shear stress at the wall is found to be a function of a nondimensional parameter $b^2(0) / \gamma$ defined in the text.

From authors' summary

471. Bernstein, I. B., Frieman, E. A., Kruskal, M. D., and Kulsrud, R. M., An energy principle for hydromagnetic stability problems, *Proc. roy. Soc. Lond. (A)* **244,** 1236, 17–40, Feb. 1958.

Stability problem of static, highly conducting, fully ionized plasmas is investigated by means of an energy principle. The conditions under which it applies are given. Method is applied to find complete stability criteria for two types of equilibrium situations. The first concerns plasmas which are completely separated from magnetic field by an interface. Second is a general axisymmetric system.

From authors' summary by O. K. Mawardi, USA

472. Chester, W., The effect of a magnetic field on Stokes flow in a conducting fluid, *J. Fluid Mech.* **3,** 3, 304–308, Dec. 1957.

Paper is an extension of the classical Stokes flow problem defining the drag force experienced by a sphere in a fluid stream. The author treats the case of a magnetic field associated with a conducting fluid. In particular, an incompressible viscous conducting fluid is considered. The flow is assumed to be steady, and the magnetic field at infinity is uniform and in the direction of the stream. The model is restricted to small Reynolds numbers, small magnetic Reynolds numbers, and small Hartman numbers. Thus a solution in powers of the Hartman number can be obtained. The final equation for the drag is then found to be

$$D = \left\{D_s\ 1 + 3/8M + 7/960\ M^3 - 43/7680\ M^3 + 0(M^4)\right\}$$

where D_s is the drag force experienced by a small sphere and M is the Hartman number in the author's nomenclature.

The paper is concisely presented. It should be very helpful to those interested in further studies of either analytical or experimental nature. A. B. Cambel, USA

473. Ostroumov, G. A., Some hydrodynamic phenomena accompanying the passage of a current through an insulating liquid (in Russian), *Zh. eksp. teor. Fiz.* **30,** 2, 282–286, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3042.

Experiments made with turpentine, benzene, nitrobenzene, petrol and transformer oil are described which have shown that, in a powerful, electric, nearly homogeneous field, these liquids are imparted a motion which does not depend on the sign of the applied voltage. *Courtesy Referativnyi Zhurnal, USSR*

Translation, courtesy Ministry of Supply, England

474. Crausse, E., and Poirier, Y., Note on some liquid flow problems with electromagnetic influences (in French), 9th Congrès intern. Mecan. appl., Univ. Bruxelles, 1957; **3,** 26–36.

475. Agostinelli, C., Magnetohydrodynamical waves in an incompressible fluid mass of circular shape (in French) 9th Congrès intern. Macan. appl., Univ. Bruxelles, 1957; **3,** 42–45.

476. Shercliff, J. A., The flow of conducting fluids in circular pipes under transverse magnetic fields, *J. Fluid Mech.* **1,** 6, 644–666, Dec. 1956.

The rate of flow of a liquid can be measured by passing it along a pipe under a transverse magnetic field. The voltage induced between two electrodes situated at the ends of a diameter of the pipe perpendicular to the flow and to the field can then be used to determine the rate of flow. The conductivity of the pipe walls and the form of the velocity profile affect the ratio of induced voltage

to flow rate. The present paper comprises analytic study of the steady state of laminar flow in a circular pipe with thin conducting walls under a traverse field and, by means of a Rayleigh approximation, the entry length necessary to achieve it.

Formulation of the equations of performance and the spatial boundary condition is followed by steady-state solution under certain simplifying assumptions to the end that a plot of sensitivity (a measure of flowmeter output) S versus wall conductivity is afforded; increase of the latter increases the former, due to change in velocity profile. A subsequent analysis of the entry problem for initial uniform velocity yields a plot of sensitivity S and dimensionless pressure gradients $\partial p/\partial z$ as a function (essentially) of a parameter ratio characterizing entry conditions. Experimental work using two Perspex pipes of 0.5 and 0.025-in. internal diameters affords good confirmation of the results of the entry effect investigation.

This excellently written paper should prove of value to all interested in electromagnetic flowmeters.

T. J. Higgins, USA

Aeroelasticity

(See also Rev. 334)

477. Huss, C. R., and Donegan, J. J., Effect of the proximity of the wing first-bending frequency and the short-period frequency on the airplane dynamic-response factor, *NACA TN* 4250, 30 pp. + 14 figs., June 1958.

Three-degree-of-freedom longitudinal analysis involves pitching, heaving, and wing first-bending mode, with triangular-impulse time history of elevator displacement. Center of gravity response is compared for following cases: (1) dynamic aeroelastic effects included, (2) quasi-static aeroelastic effects included, (3) airplane rigid. Results show dynamic aeroelastic effect may increase maximum acceleration by a factor of 1.6 when damped wing-bending frequency is equal to frequency of short-period mode, but becomes negligible when ratio of former to latter frequency exceeds 6. Simplifications in analysis indicated, and applied in obtaining results G. Isakson, USA

478. Chawla, J. P., Aeroelastic instability at high Mach number, *J. aero. Sci.* **25,** 4, 246–258, Apr. 1958.

Equations are derived for flutter speeds and frequencies of a two-dimensional airfoil free to move vertically and to pitch, when moving at supersonic speeds. A linear approximation to the pressure downwash relation is adopted in calculating derivatives. Particular formulas for special sections are given. Application is made to a cantilever wing using semirigid bending and torsion modes and strip theory for the aerodynamic forces. Parametric studies are made of a number of flutter problems and many valuable graphs are presented. These are very useful for preliminary design assessment. W. S. Hemp, England

479. Shen, S. F., and Hsu, C. C., Analytical results of certain nonlinear flutter problems *J. aero. Sci.* **25,** 2, 136–137 (Readers' Forum), Feb. 1958.

480. Watson, J., Calculation of derivatives for a cropped delta wing with subsonic leading edges oscillating in a supersonic air stream, *Aero. Res. Counc. Lond. Rep. Mem.* 3060, 30 pp. + 1 table + 8 figs., 1958.

The lift, pitching moment, and full-span constant-chord control hinge-moment are derived for a cropped delta wing describing harmonic plunging and pitching oscillations of small amplitude and low-frequency parameter in a supersonic air stream. It is assumed that (a) the wing has subsonic leading edges, (b) the wing is sufficiently thin and the Mach number sufficiently supersonic to permit the use of linearized theory.

From author's summary by P. C. Dunne, Brazil

481. Watson, J., Calculation of derivatives for a cropped delta wing with an oscillating constant-chord flap in a supersonic air stream, *Aero. Res. Counc. Lond. Rep. Mem.* 3059, 24 pp. + 4 tables + 17 figs., 1958.

The lift, pitching moment and hinge moment are derived for a delta wing with a trailing edge flap of constant chord when the wing is at zero incidence in a supersonic air stream and the flap oscillates harmonically with small amplitude and low frequency. It is assumed that the wing is sufficiently thin and the amplitude of oscillation sufficiently small to permit the use of linearized theory.

The investigation covers partial-span flaps; in each case there is a lower limit to the Mach number for which the theory applies. The theory is shown to apply without appreciable error, provided the frequency parameter based on mean chord does not exceed 0.4. The calculated values of hinge-moment damping are compared with preliminary experimental values obtained at the National Physical Laboratory.

From author's summary by P. C. Dunne, Brazil

482. Williams, D. E., On the integral equations of two-dimensional subsonic flutter derivative theory, *Aero. Res. Counc. Lond. Rep. Mem.* 3057, 21 pp., 1958.

Method of solution of Birnbaum's integral equation fo. incompressible flow is extended to solve the Possio integral equation in analytic form. Singular solutions are developed in terms of the solutions of the associated eigenvalue integral equation. Solution agrees, although in different form, with that of Timman and van de Vooren. H. M. Voss, USA

483. Hall, H., The effect of wing torsion on aileron-tab flutter, *Aero. Res. Counc. Lond. Rep. Mem.* 3072, 12 pp. + 7 figs., 1958.

484. Oat, R., and Trubert, M., Application of an experimental method for the determination of unsteady aerodynamic forces on a rigid wing oscillating in a wind tunnel (in French), *ONERA NT* 44, 22 pp., 1958.

The frequency and damping of a small model are measured in a two-dimensional flow for a given degree of freedom (in pitch or vertical translation) for various air speeds, the model being excited at the resonant frequency. By altering the inertia of the model a range of frequencies can be covered. No phase measurement is needed. The free motion of the model was also observed. Greater accuracy was obtained for the aerodynamic coefficients by using harmonic excitation. There was good agreement with the theoretical coefficients for motions of translation, but there was some dispersion in the results for the pitching coefficients for moderate and high frequencies.

Experiments were also carried out on a wing with two degrees of freedom, and a comparison of these results with those based on the two-dimensional coefficients determined experimentally indicate that the accuracy of this method is quite good; however, these experiments are restricted to low values of the reduced frequency and to low Reynolds numbers.

A. W. Babister, Scotland

485. Calvert, H. F., and Smith, G. T., Vibration survey of four representative types of air-cooled turbine blades, *NACA TN* 4100, 11 pp. + 2 tables + 9 figs., July 1958.

The vibrational characteristics, frequencies, and stresses were determined both with and without coolant flow for four types of air-cooled turbine blades utilized in turbine-cooling research. Two types had a standard 4-in. span and two types had a long 6¼-in. span. The blade vibrational frequencies increased from 2 to 3% with coolant flow. The standard-span blades exhibited only resonant-type vibrations, whereas the long-span blades vibrated at all engine speeds. Static fatigue tests were also conducted with the same blades used for the engine investigation.

From authors' summary

Aeronautics

(See also Revs. 182, 295, 327, 386)

Book—486. Conway, H. G., Landing gear design, New York, Macmillan Company, 1958, viii + 342 pp. $12.

Textbook presents a comprehensive survey of the many different problems of concern to landing-gear designers and discusses procedures which are used to meet these problems in practice. Attention is directed to conventional design techniques, unorthodox techniques, and techniques of historical interest; major emphasis, however, is placed upon practical design advice for current use.

Chapters 1 and 2 cover the historical development of the landing gear and discuss possible and practical wheel arrangements. Chapter 3 discusses energy absorption during landing. Chapters 4, 5, and 6, respectively, discuss types, construction, properties, and selection of tires, wheels, and brakes. Chapter 7 discusses general layout and kinematic properties of landing-gear units. Chapter 8 discusses detail design. Chapters 9 and 10 cover shock absorbers and gear retraction mechanisms. Chapter 11 discusses stressing criteria, stress analysis, strength tests, and material selection. Chapter 12 discusses unorthodox landing gears (skis, skids, trolleys, helicopter, etc.).

Book is based upon 15 years of continuous experience by the author in landing-gear design and production. It is well illustrated with sketches and photographs (368 illus.) and contains many tables, graphs, and equations to facilitate practical design calculations. Reviewer believes this book can provide engineers and students with a good practical introduction to all major phases of landing-gear design problems and can also serve as a handbook for many preliminary design considerations.

R. F. Smiley, USA

487. McBrearty, J. F., A review of landing gear and ground loads problems, *AGARD Rep.* 118, 9 pp. + 2 tables + 20 figs., Apr./May 1957.

Paper presents a brief assessment of the aircraft weight attributable to the landing gear and ground loads in general and a discussion of some of the less common ground loads phenomena which have become more and more important to aircraft design. Skidding oscillations, brake chatter, shimmy, taxying loads, and fatigue are singled out for more detailed consideration. Discussion of the methods employed to provide practical solutions to these problems is presented. It is concluded that experimental development techniques in conjunction with analytical methods provide reasonably satisfactory designs but that a great deal of operational data is needed to refine the design targets for these phenomena. From author's summary

488. Lecomte, P., Use of angle of attack indication for landing on short runways (in French), *AGARD Rep.* 30, 3 pp. + 3 figs. + appendix, Feb. 1956.

Landing on relatively short runways raises various technical problems. The present report gives details on the use of the angle-of-attack indicator for approach and the advantages from the point of view of a decrease in approach speeds and an increase in the accuracy of touchdown. From author's summary

489. Calvert, E. S., and Sparke, J. W., The effect on weather minima of approach speed, cockpit cut-off angle and type of approach coupler for a given landing success rate and level of safety, *Aero. Res. Counc. Lond. curr. Pap.* 378, 13 pp. + 7 figs., 1958.

490. Cheeseman, I. C., and Bennett, W. E., The effect of the ground on a helicopter rotor in forward flight, *Aero. Res. Counc. Lond. Rep. Mem.* 3021, 7 pp. + 10 figs., 1957.

An approximate method of estimating the effect of the ground on the lift of a rotor at any forward speed is described. Flight tests on several different helicopters show reasonable agreement with the theory. Curves are given showing the relation between thrust, height, speed and power.

The theory has been extended to include the effect of a variation in blade loading coefficient and shows that, within the range that this parameter takes on present single-rotor helicopters, the effect is small.

The effect of fitting flat surfaces beneath the rotor is also considered and it is shown that the ratio of the thrust in the ground cushion to the thrust clear of the ground, at constant power, is greater for the winged helicopter, but that for the same rotor operating at constant power, the clean helicopter will have the higher net thrust for speeds less than the stalling speeds of the attached surfaces. From authors' summary

491. Yeates, J. E., Jr., Brooks, G. W., and Houbolt, J. C., Flight and analytical methods for determining the coupled vibration response of tandem helicopters, *NACA Rep.* 1326, 31 pp., 1957.

492. Eggers, A. J., Jr., Performance of long range hypervelocity vehicles, *Jet Propulsion* **27,** 11, 1147–1151, Nov. 1957.

Paper compares the performance of hypervelocity vehicles capable of long-range flight. Using the cost of delivering a given pay-load a given range as a measure of performance and adopting the initial mass m_i of the vehicle as a measure of cost, paper starts with the basic performance equation $m_i = m_f e^{V_f / (I_e g)}$ where m_f and V_f are final mass and final velocity, respectively, at end of powered flight, I_e is the effective specific impulse of power plant. Assuming I_e to be a fixed quantity for all vehicles to be compared, three types of trajectories (glide, skip, and ballistic trajectories) for the unpowered part of the flight are studied, only those trajectories being treated which yield maximum range for given V_f. Attention is restricted to two main performance considerations: the influence of the trajectory on the required burn-out velocity, and the resulting aerodynamic heating as it influences structure, equipment and coolant.

Without regard to aerodynamic heating both skip and glide vehicles are superior to the ballistic vehicle in their ability to convert velocity into range, this superiority becoming more marked if the aerodynamic lift-drag ratio is greater. Study of the total heat transfer (which determines the mass of coolant required), of the average heat-transfer rate (which, as the case may be, is significant for the level of surface temperature with radiation-cooled vehicle, for average flow rates with fluid coolants, for overall structural strength of the vehicle in general), and of stagnation heat-transfer rate (as representative for excessive local heating) results in the following statements: Large aerodynamic loads and severe aerodynamic heating are encountered by the skip vehicle during the skipping process, these facts classifying this vehicle as the least attractive of the three types. The disadvantage of the ballistic vehicle named above can be offset by using a blunt body, thus reducing convective heat transfer by increasing pressure drag in relation to friction drag. The glider has the disadvantage of having far more heat converted to it, but it has the compensating advantage that this heat can be radiated back to the atmosphere, and it is generally better suited than the ballistic vehicle for manned flight at hypervelocities.

Regarding the design of a manned glide vehicle it is argued that body nose and wing leading edge should be blunt, the wing being of the highly swept delta type, a vertical tail providing directional stability and control.

Finally, the re-entry and recovery problem of satellite vehicles as a limiting case of the ballistic vehicles is treated briefly.

H. Behrbohm, Sweden

493. Taylor, J., Allen, J. E., and Smith, A. G., Flight investigation of some airworthiness problems of civil boat seaplanes, *Aero. Res. Counc. Lond. Rep. Mem.* 3017, 29 pp. + 4 tables + 29 figs., 1958.

Astronautics

(See also Revs. 121, 461, 463, 492, 573)

Book—494. Alperin, M., Stern, M., and Wooster, H., editors, Vistas in astronautics, New York, Pergamon Press, 1958, xxi + 330 pp. $15.

Volume represents the proceedings of the first AFOSR Astronautics Conference (February 1957). Papers are grouped as follows: re-entry, tracking and communications, environment and measurements, propulsion, orbits, and human factors. Individual papers differ quite widely—a few constitute rather complete surveys or original contributions, but most are merely abstracts.

This is a somewhat undistinguished addition to the already existing multitude of high-priced proceedings of symposia on space flight and related topics. H. N. Abramson, USA

495. Vertregt, M., Interplanetary orbits, *J. Brit. interplanetary Soc.* **16,** 6, 326–354, (Mar./Apr.) 1958.

Author has given an excellent exposition of how to plan, in general, one's trip to another planet. He neglects all forces except the sun's gravitation, as well as ellipticity and inclination of the planetary orbits. His results are graphed in three compatible diagrams showing (a) energy, (b) time, and (c) initial configuration required for a voyage between the earth and a given planet (specifically, Venus), as functions of the eccentricity and semi-major axis of the space-ship's orbit.

Author also points out in an addendum that an improved treatment is possible by using the semi-latus rectum rather than the semi-major axis as a parameter. R. E. Gaskell, USA

496. Roberson, R. R., Vertical ballistic trajectories over an oblate earth, *Jet Propulsion* **28,** 5, p. 333, May 1958.

Previous results on impact points of ballistic rockets on an oblate earth are modified to include the case of vertical trajectories. From author's summary

497. Rowland, E. N., A note on space travel in a gravitational field, *J. Brit. interplanetary Soc.* **16,** 4, 216–221, Oct./Dec. 1957.

498. Mandelker, J., Classical and relativistic motion of a particle whose mass increases with velocity (in English), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **5,** 39–47.

499. Hoffman, G. A., A look at "whiskers," *Astronautics* **3,** 8, 31–33, Aug. 1958.

Now only a laboratory curiosity, crystal filaments with the strength of atomic cohesion may be the key to light strong spaceship structures. From author's summary

500. Miele, A., Generalized variational approach to the optimum thrust programming for the vertical flight of a rocket (in English), *Z. Flugwiss.* **6,** 3, 69–77, Mar. 1958.

The burning program for the vertical flight of a rocket-powered vehicle is analyzed. The results of previous theories are extended to cover the general problem of minimizing the difference between the final and initial values of an arbitrarily specified function of time, mass, velocity and altitude. By using the indirect methods of the calculus of variations it is shown that the totality of extremal arcs is composed of zero-thrust sub-arcs, sub-arcs to be flown with maximum engine output and variable-thrust sub-arcs. An explicit solution is determined for the optimizing mass flow of the rocket engine as a function of the local coordinates of the missile. Closed form solutions are obtained for the relationships between time, mass, altitude and velocity for the following particular cases: flight in a vacuum, flight in a uniform atmosphere and flight in an isothermal atmosphere. The boundary-value problem is investigated for an isothermal atmosphere. A numerical example is included to illustrate the general procedure developed in the present analysis. From author's summary

501. Olds, R. H., Optimum variation of exhaust velocity during burning *Jet Propulsion* **28,** 6, 405–406 (Tech. Notes), June 1958.

In the case of a vertically launched rocket with a fixed initial amount of propellant energy the optimum distribution of energy with respect to the propellant results in an exhaust velocity that increases during burning in accordance with the formula $c = c_0 + v + gt$. From author's summary

502. Baumann, R. C., Design, fabrication and testing of the Vanguard satellite, *Jet Propulsion* **28,** 4, 244–245, Apr. 1958.

Flight and orbital environmental conditions exert a great influence on satellite design. As information on these conditions changed and became firm the satellite design went through numerous stages. Material selected for the satellite shell and structure is magnesium alloy FS-1. Design and operation of the structure and shell, antennas and separation mechanism are discussed. Methods for control of satellite temperatures are thermal isolation of the inner package, shell coatings and thermal switches. From a circular blank disk, a near perfect hemisphere, only 0.026 in. thick, is formed to make the satellite shell. Tubes are formed and welded to make up the "bird cage" internal structure. Fitting and assembly of the satellite involve jeweler's precision on the part of several groups. Satellite structural components are design-tested individually at first. The assembly is then tested to the expected environmental conditions of acceleration, vibration, vacuum, and temperature. From author's summary

503. Klemperer, W. B., and Benedikt, E. T., Selenoid satellites (in English), *Astronaut. Acta* **4,** 1, 25–30, 1958.

Discussion of the Lagrangian solution of the restricted three-body-problem of constant configuration. The five possible positions are the inferior and superior conjunction, the opposition, and two "trojan" positions or sextiles. These positions are computed for a symperiodic Moon companion of the Earth and an Earth companion of the Sun. From authors' summary

504. Ferri, A., Feldman, L., and Daskin, W., The use of lift for re-entry from satellite trajectories, *Jet Propulsion* **27,** 11, 1184–1191, Nov. 1957.

While in a paper by N. H. Kemp and F. R. Riddell [AMR **10** (1957), Rev. 4181] *complete* balance of radiant and convective heat transfer was sought during the re-entry trajectory of a lifting vehicle and, thus, somewhat negative conclusions had been reached, present paper tries to show that lifting vehicles can re-enter the atmosphere without the use of heat sinks much larger than the inherent heat sink of the structure. The solution is sought in the combination of properly chosen trajectories with carefully selected geometry of the body, using drag-producing surfaces which without appreciable increase in structural weight are capable of producing a comparable amount of lift (in order to increase radiation, use of open-type lifting surfaces is suggested).

Assuming the stagnation heat transfer to be representative for the level of heat transfer at the surface of the body and using results of L. Lees [AMR **10** (1957), Rev. 3390] and M. Romig [*Jet Propulsion* **26,** 1098–1101, 1956] on stagnation point heat transfer over blunt-nosed bodies for hypersonic flow, three types of trajectories are analyzed, starting with the same initial conditions (300,000 ft of altitude and 26,000 fps velocity) in all cases. The first trajectory has constant path angle and is close to a ballistic one; the second is one having constant lift and drag coefficients during its first portion and horizontal flight with constant drag coefficient for the remainder of the trajectory; the third one is a damped phugoid, the flight path being a skipping one. Although paper gives no optimizing investigations, it may be concluded that

among the three trajectories analyzed the phugoid-type trajectory is the most promising one with regard to alleviation of the aerodynamic heating problem. H. Behrbohm, Sweden

505. Bednarczyk, H., Contribution to the theory of steam rockets (in German), *Astronaut. Acta* **3**, 2, 153–177, 1957.

Thermodynamic phenomena in a steam rocket are analyzed and equations for the design are given. The following problems are discussed: Outflow of hot water from the boiler (connection between pressure and amount of fluid in the vessel), measures against unwanted delay in boiling during expansion in the nozzle, calculating of LAVAL states in the nozzle, calculation of thrust, design of the nozzle. It was attempted to present the equations in a form suitable for immediate application by using only standard thermodynamic quantities of state. In some cases certain equations are treated graphically and solutions are given over the whole range of practical interest. Finally the need for further experimental research is pointed out in connection with some as yet unsolved problems. From author's summary

506. Bartz, D. R., Factors which influence the suitability of liquid propellants as rocket motor regenerative coolants, *Jet Propulsion* **28**, 1, 46–53, Jan. 1958.

The measurement of the stagnation pressure and, from this, the velocity of the gas phase, in a stream of gas laden with liquid droplets or solid particles is investigated theoretically and experimentally. The three requirements of a successful design are as follows: (1) To prevent flooding of the probe and pressure lines with particles, the rear of the probe must be vented by an orifice of appropriate size. Moreover, pressurized manometers with a special operating technique must be employed. (2) To minimize the effects of aerodynamic interactions outside the probe, the latter must be made sufficiently small. (3) To minimize the effects of aerodynamic interactions within the probe, the internal pressure tap must be situated close to the nose of the probe. The phenomena associated with the momentum interchanges between gas and particles are analyzed, and quantitative evaluation is made of the associated error recorded by a total pressure probe. For convenience in design the magnitude of the error is presented graphically in terms of the probe dimensions and the properties of the gas and particle flows. The theoretical findings are checked by the testing of a series of experimental probes of varying geometry in an air stream carrying water droplets. Satisfactory agreement exists between theory and experiment. It is shown that a practical probe can be built to give a negligible error in the measurement of stagnation pressure in the range of variables investigated. Further it is found possible, with simple modifications, to adapt the experimental probe conveniently to the local measurement of other stream properties, namely, the mass rate of flow per unit area of particles, the particle size, and the particle velocity. From author's summary

507. Williams, M. L., The calculation of fuel distribution in step-rockets, *J. Brit. interplanetary Soc.* **16**, 4, 211–215, Oct./Dec. 1957.

Ballistics, Explosions

(See also Revs. 306, 496)

508. Potter, R. L., and Wayman, D. H., The detonatability envelope of gaseous fuming nitric acid-*n*-heptane-nitrogen mixtures as a function of initial pressure, *Combustion and Flame* **2**, 2, 129–136, June 1958.

Detonatability limits for the system fuming nitric acid-*n*-heptane-nitrogen have been established over initial pressure varying from one half to two atmospheres. At the limits of detonatability, the Chapman-Jouguet temperatures are everywhere above 2900 K, the majority being about 3000 K. These limits correlate qualitatively with the rate of decomposition of nitric oxide as the limiting reaction rate in the sequence of reactions in the steady zone. From authors' summary

509. [illegible]ior, R. A., and Greyber, H. D., Calculation of shock Hugo[illegible]nd related quantities for nitrogen and oxygen, *Physics of Fluids* **1**, 2, p. 160, Mar.-Apr. 1958.

510. Oshima, K., Experiments on the cylindrical blast waves, *J. phys. Soc. Japan* **12**, 12, p. 1421 (Short notes), Dec. 1957.

511. Powley, H. S., Determination of rifle trajectories, *J. Franklin Inst.* **264**, 5, 379–389, Nov. 1957.

Acoustics

(See also Revs. 232, 294)

512. Moore, F. K., Propagation of weak waves in a dissociated gas, *J. aero. Sci.* **25**, 4, 279–280, Apr. 1958.

An analytical study of dynamics of weak disturbances in a gas not in thermodynamic equilibrium is outlined. Author develops a modified wave equation using linearized disturbance equations combined with simple energy and gas constant relationships for a diatomic gas. Resulting equation can be interpreted as consisting of an equilibrium as well as a "frozen" dynamic process. Propagation speed is shown to vary markedly during a cycle. Thus a mechanism for wave-form distortion is displayed in the linearized model. Author states method presents no new results but may be useful (if developed further) in formulating an aerodynamic theory of weak disturbances in flow behind a shock during hypersonic flight at extreme altitudes.

Reviewer believes analysis gives additional insight into the processes of this type of wave propagation.

R. B. Grant, USA

513. Olsen, H., Romberg, W., and Wergeland, H., Radiation force on bodies in a sound field, *J. acoust. Soc. Amer.* **30**, 1, 69–76, Jan. 1958.

Paper discusses the radiation force on a body due to the presence of a sound wave. If the body is rigid, the radiation force is determined by the scalar pressure alone, but for a deformable body the radiation force is a tensor, and the direction of the force does not have to coincide with the direction of the wave. The connection between the force and the scattering cross section is examined and a force factor κ

$$\kappa = \overline{K}_z / \tfrac{1}{2}(\rho_0 k^2 \sigma_{sc})$$

is found, where $\overline{K}_z$ is the time average radiation force, ρ_0 the density, k the wave vector, and σ_{sc} the scattering cross section. It is found that $\kappa = 1$ for plane scatters at perpendicular incidence. It is shown that neither for very long wave lengths nor for very short wave lengths is κ equal to 1. The case of the rigid sphere is treated in detail. W. P. Mason, USA

514. Richardson, E. G., The flow and sound field near a cylinder towed through water, *Appl. sci. Res.* (*A*) **7**, 5, 341–350, 1958.

After a survey of previous work on the wake and sound fields of a cylinder moving through air, a description is given of apparatus designed to record the fluctuations of velocity (recorded by hot-wire) in the wake of a cylinder towed through water and the fluctuations of pressure in its vicinity (recorded by probe hydrophone). The results show that the two types of measurement are correlated and consistent with the field of a dipole source. The Strouhal number as measured is consistent with a forced vibration of the

cylinder over quite a range of speed. Attention is drawn to some possible applications of the results.

From author's summary

515. Chase, C. E., Propagation of ordinary sound in liquid helium near the λ point, *Physics of Fluids* **1,** 3, 193–200, May–June 1958.

The velocity and attenuation of ordinary sound in liquid helium have been measured at a frequency of 1 Mc/sec in the neighborhood of the λ point. By using measuring techniques of high resolution, it was possible to observe the behavior in this region in considerable detail. The velocity passes through a minimum approximately 2×10^{-4} °K below the λ point; the maximum attenuation occurs about 8×10^{-5} °K below T_λ. Both velocity and attenuation behave in a manner characteristic of a relaxation process, with the relaxation time a rapid function of temperature near T_λ. The results below T_λ can be described with good quantitative accuracy if this relaxation time is given by $\tau = 8.8 \times 10^{-12}(T_\lambda - T)^{-1}$.

Excess attenuation is also observed above the λ point; this cannot be explained by the above relaxation process. The experimental uncertainties are so large in helium I that no reliable conclusions can be reached, but there is some indication that the quantity α/ω^2 is not independent of frequency in this region.

The behavior of the velocity is considered with regard to the Ehrenfest relations, and it is shown that the discontinuity in isothermal compressibility which those relations predict must be almost entirely due to a discontinuity in γ. No contradiction of the Ehrenfest relations is implied, since present knowledge of γ suggests that a discontinuity of the required magnitude may indeed occur.

From author's summary

516. Bazilevich, V. V., and Tverskoi, N. P., Freezing of drops of a supercooled water mist in an acoustic field, *Soviet Phys.-Tech. Phys.* **2,** 8, 1696–1699, May 1958. [Translation of *Zh. Tekh. Fiz., Akad. Nauk SSSR* **27,** 8, 1826–1829, Aug. 1957 by Amer. Inst. Phys., Inc., New York, N. Y.]

517. Gladkov, A. V., The structure of glasses and ultrasonic propagation velocities (in Russian), *Soviet Phys.-Tech. Phys.* **2,** 4, 612–617, Feb. 1958. [Translation from *Zh. tekh. Fiz., Akad. Nauk SSSR* **27,** 4, 682–687, Apr. 1957 by Amer. Inst. Phys., Inc., New York, N. Y.]

518. Claydon, D. G. W., Instrumentation in ultrasonic flaw detection, *J. Inst. Metals* **86,** 10 pp., 1957–1958.

The method of generating ultrasonic pulses and their behavior at an interface are first described, and the oil-film, immersion, and irrigation methods of coupling, together with various aspects of the design and use of probes, are reviewed and illustrated by examples. A technique for the assessment of defect size is mentioned, and the characteristics of the ultrasonic beam which affect this are considered in detail.

In order to facilitate an understanding of the means employed for presenting easily interpreted information on defects, an outline is given of the types of electronic unit involved. In a section on alarm and recording systems, a brief explanation of the type of circuitry used is presented, and examples of various methods of recording are described. This is followed by an examination of the basic requirements for automatic units.

Finally, there is a general discussion on the best methods of construction of ultrasonic flaw detectors to make such instruments suitable for the many applications which exist in industry today.

From author's summary

519. Wolfe, M. O. W., Near field jet noise, *AGARD Rep.* 112, 9 pp. + 32 figs., Apr./May 1957.

This paper deals with the subject of jet engine noise in relation to its effects on aircraft structures. Near field noise measurements are described for a range of jet shear velocities on two representative turbojet engines, one of them operating with an afterburner. Contours of equal noise pressure in the horizontal plane containing the axis of the jet are presented for a range of shear velocity for over-all noise pressure and for noise pressures in ⅓ octave frequency bands in the noise spectra. In the velocity range 790 to 1800 fps, 400 cps is the dominant frequency. At most velocities the noise pressures at this frequency are about 10 decibels less than the corresponding over-all noise pressures. The increase in noise level due to reheat is not as great as would have been predicted from a consideration of the noise level trends at much lower values of velocity without reheat.

From author's summary

Micromeritics

(See also Revs. 406, 410, 516)

520. Hawksley, P. G. W., Badzioch, S., and Blackett, J. H., Improved sampling equipment for solids in flue gases, *J. Inst. Fuel* **31,** 207, 147–160, Apr. 1958.

Equipment is described that is suitable for the separate determination of grit, dust and smoke concentrations in flue gases. The equipment, designed as a result of extensive testing, has interchangeable parts and can be assembled in different forms for the purpose in hand. Local solids concentrations can be determined in a matter of minutes. The equipment is suitable both for routine measurements and for detailed investigations of the distributions of solids in ducts or for studying the effects of the operating conditions of the plant. The method of use is described. The simplest version of the equipment consists of a small (1½-in. diameter) dust-collecting cyclone which is inserted bodily into the gas stream at the end of a probe. The cyclone itself is used as a flowmeter. This unit when operated at sampling rates above 5 cu ft/min at N.T.P. collects all dust particles above 5 to 10 microns. Grit particles above 76 microns (200 B.S. mesh) are separated from the dust by sieving. For the collection of smoke particles below 5 to 10 microns, the cyclone is backed with a glass-wool filter.

From authors' summary

521. Klumb, H., and Schuetz, A., Investigations on the electrical charging of aerosols (in German) *Z. Aerosol-Forsch. und -Therapie* **6,** 1, 40–53, June 1957.

A chamber for measuring the size and charge of aerosol particles is described. Both the charge naturally acquired by the atomization process and an intentionally produced charge by corona discharge were investigated. The experimentally found relationships between the charge and the size and dielectric constant of aerosol particles, and the ionization density of the corona discharge can be interpreted on theoretical basis. Attention is called to the influence of the charge on the stability of the aerosol. The chamber, the charging arrangement, and the experimental method and its evaluation are described and illustrated.

K. J. DeJuhasz, Germany

522. Bruun, P., and Gerritsen, F., Stability of coastal inlets, *Proc. Amer. Soc. civ. Engrs.* **84,** WW 3 (*J. Wwys. and Harbors Div.*), Pap. 1644, 50 pp., May 1958.

Study of relationship between tidal range, tidal prism, and inlet cross section. Numerous formulas are derived, starting from the work of Lane, Keulegan, Kalinske, Meyer-Peter, Einstein, O'Brien, Straub, and others. Data from 32 inlets in the U. S., Denmark and Holland are plotted, showing that the average ratio of tidal prism in acre-ft to inlet cross section in sq ft is 1.17. Effects of fresh water outflow, suspended and bed load material, and quantity and type of littoral drift are discussed. Model studies of Lake Worth Inlet, Florida, are reported. Authors feel that designs should be checked by model studies, but that fixed bed models may be used.

A good bibliography is given but the paper suffers from lack of editorial revision and careful proof reading. Many misprints were noted.

R. W. Powell, USA

523. Brosskamp, K. H., Sand transport in pressure pipelines (in German), *Bautechnik* **34,** 11, 410–417, Nov. 1957.

Three cases are distinguished: (a) "Sliding" transport in dense phase along the bottom of a horizontal pipe; (b) "saltation" transport; and (c) dilute phase transport. In case (b), distribution of sand is still nonuniform, being more dense near the bottom, while in case (c) distribution is practically uniform. Difference between lateral turbulence velocities and settling velocities of particles is thought to be a useful criterion for the transition between the three conditions. For the magnitude of these turbulence velocities the wall-friction velocity u^* is assumed. Thus, "saltation" transport occurs if $u^* \approx$ settling velocity, and dilute transport if u^* is much greater than settling velocity. Surprisingly, the effect of concentration is not considered. Empirical pressure-drop relations and diagrams are given for flow of water alone through smooth and rough tubes, which relations may also be used for dilute transport provided the density of the mixture is taken.

Attempt is made to discuss the phenomena in the light of present knowledge about turbulent flows; but these discussions are very poor. It seems to reviewer that in this respect author has heard something about it, but he does not know the facts of it.

J. O. Hinze, Holland

524. Deriagin, B. V., and Bakanov, S. P., The theory of the motion of small aerosol particles in a diffusion field, *Soviet Phys.-Doklady* **2,** 6, 563–567, July 1958. [Translation of *Doklady Akad. Nauk SSSR (N.S.)* **117,** 1/6, 959–962, Nov./Dec. 1957, by Amer. Inst. Phys., Inc., New York, N. Y.]

Authors' previous work considered the forces acting in a diffusion field on an aerosol particle having a radius much larger than the mean free molecular paths, taking account of the boundary conditions on the surface of the particle. One of the conditions is the absence of slipping of the gaseous mixture on particle surfaces under isothermal conditions. This condition is violated in the presence of the temperature gradient which results from thermophoresis. A question arises as to whether slipping and "phoresis" result from a concentration gradient which must be taken into account in a complete theory of the behavior of aerosol particles in diffusion fields. A rigorous gas-kinetic calculation of such "diffusion phoresis" is complicated by the fact that the velocity distribution of gas molecules in a layer of thickness corresponding to the free molecular path depends on distance from a particle surface.

Present research aims to solve this problem with a detailed mathematical analysis. Application of this analysis is made to pseudomolecular flow through a highly porous body.

K. J. DeJuhasz, Germany

525. Miesse, C. C., Effect of high altitude conditions on atomization phenomena, *Jet Propulsion* **28,** 5, 335–337, May 1958.

Jet aircraft and rockets must maintain combustion at extreme altitudes. Combustion of liquid propellants depends on adequate atomization, evaporation, and penetration; therefore the effect of high altitude on these phenomena is of paramount importance. Author reviews previous researches of Garner and Henny, Kuehn, Lee, Woeltjen, and Littaye, and presents plots of Sauter Mean Diameter for various fuels as a function of ambient pressure, also a chart of relative droplet diameter as a function of Reynolds number. Author also derives equations for the droplet life time, and comes to the conclusions that: (1) the initial Sauter Mean Diameter at high altitude (i.e., lower ambient pressure) is slightly larger than at sea level, (2) the vaporization rate is greater, and (3) the penetration distance is less owing to the shorter droplet life time.

K. J. DeJuhasz, Germany

526. Hrubecky, H. F., Experiments in liquid atomization by air streams, *J. appl. Phys.* **29,** 3, 572–578, Mar. 1958.

Water is atomized by a high-velocity air stream using various methods of injection and water nozzle positions. Low water volume rates and velocities, air velocities up to acoustic, and ratios of air volume to water volume rates up to 25,000 were utilized. Highest degree of atomization was achieved when the water was injected into region of maximum velocity of the air stream, and parallel to it. Comparison is made with the Nukiyama-Tanasawa correlation; discrepancies in droplet sizes at high air velocities are found and discussed.

Experimental apparatus is described, and illustrated schematically; the liquid nozzles were made of hypodermic stainless steel tubing; the drops were received on glass slides coated with magnesium oxide. Results are presented in tables and charts. A list of previous research work is given.

K. J. DeJuhasz, Germany

527. Salamandra, G. D., and Naboko, I. M., Speed microphotography of drops of an atomized liquid in flight (in Russian), *Soviet Phys.-Tech Phys.* **2,** 3, 551–554, Mar. 1957. [Translation of *Zh. tekh. Fiz., Akad. Nauk SSSR* **27,** 3, p. 619, by Amer. Inst. Phys., Inc., New York, N. Y.]

Description of method of determining size distribution of atomized fuel by rapid microphotography of liquid drops in flight. Photographing without blurring of drops traveling at several hundred mps would require light flashes of 10^{-7}-sec, or less, duration, which is difficult to attain. In the present research, flashes of only 10^{-6}, or 10^{-5}-sec duration were used in combination with an optical compensation for the drop movement by a revolving mirror in the camera. Circuit for the electric spark system and schematic of the discharge gap giving a linear light source are given. A number of microphotographs of sprays are shown. Data on speed of drops, magnification, film speed, and circuit parameters are given. Possibilities for extending the range of usability of method and equipment are discussed.

K. J. DeJuhasz, Germany

528. Salamandra, G. D., and Naboko, I. M., Catching on a plate coated with a layer of soot as a method for determining the drop-size of an atomized fuel (in Russian), *Soviet Phys.-Tech. Phys.* **2,** 3, 546–550, Mar. 1957. [Translation of *Zh. tekh. Fiz., Akad.* Nauk SSSR, 27, 3, 614–618, by Amer. Inst. of Physics, Inc., New York, N. Y.]

Most widely used method for determination of drop-size distribution of atomized fuel is the catching of the drops on an impressionable surface, in the present research on a layer of soot covered by a layer of magnesium oxide. Drops falling on the surface penetrate the white layer of mangesium oxide and form craters in the underlying black layer of soot. The size of the impression is some definite function of the drop size producing it. The further processing of the results is done by microphotographic methods, which are simple though laborious. Relation between diameter of impression and of drop was determined by numerous previous workers, but their results disagree. In the present research on the size-relation of impression to drop, high-speed photography (25,000 to 50,000 frames per sec) was used whereby the time-history of collision between drop and plate, and of the process of crater formation was obtained, giving a clearer insight into the basic phenomenon. Numerous photographs are shown and interpreted.

K. J. DeJuhasz, Germany

529. Sidorov, E. A., Calculation of laminar flow of drop-forming liquids through tubes, with inclusion of nonisothermal effects (in Russian), *Soviet Phys.-Tech. Phys.* **2,** 2, 292–296, Feb. 1957. [Translation of *Zh. tekh. Fiz., Akad. Nauk SSSR* **27,** 2, 327–330, by Amer. Inst. Phys., Inc., New York, N. Y.]

Variation of physical properties of liquids with temperature is one of the most important sources of disagreement between theoretical solutions and experimental data on the distributions of velocity and temperature in the laminar flow of liquids through tubes. Author states the approximate equations of motion and of heat transfer in the boundary layer in a cylindrical tube. Based on these he derives mathematically the temperature and velocity fields in laminar flow of drop-forming liquids through tubes, including the effect of viscosity variation with temperature. Previous research is discussed.

K. J. DeJuhasz, Germany

530. Tanasawa, Y., and Toyoda, S., On the atomization of liquid jet issuing from a cylindrical nozzle, *Technol. Rep. Tohoku Univ.* **19,** 2, 135–156, 1955.

The behavior of a liquid jet was investigated with the aid of very-short-duration spark illumination, at increasing pressures, resulting first in dripping, then a lengthening stream breaking into drops at the end, roughening of the stream surface and stripping of liquid filaments from it, finally the stream breaking up into droplets forming a spray. Each of these phases is investigated theoretically also, and the results are represented in charts. Effect of injection pressure on mean drop sizes is shown. A dimensionless number termed "Jet Number" is introduced as a characteristic quantity for the mode of atomization. This paper summarizes the investigations of the authors since 1936, the various previous reports on which are listed in the references.

K. J. DeJuhasz, Germany

531. Tanasawa, Y., and Kobayasi, K., A study of swirl atomizer, *Technol. Rep. Tohoku Univ.* **20,** 1, 27–58, 1955.

Report on researches extending from 1940 to 1952 on the basic principles of atomization by a swirl nozzle compares the experimental values of flow and atomization with the theoretical values. Conditions for optimal dimensions of simplex, duplex, variable-slot, and spill-control nozzles have been considered. Theory of potential flow and of viscous swirl are analyzed in detail. Modes of atomization are investigated experimentally, as dependent on (1) the form of atomizer, (2) dimensions of atomizer, (3) pressure at atomizer entry, (4) physical properties of liquid, and (5) physical properties of surrounding medium. Experimental apparatus is described, large number of spray photographs shown. Comparison is made between potential theory and actual performance, with effect of Reynolds number. Effect of inlet pressure, surface tension, length-to-diameter ratio, and of kinematic viscosity, on the size of drops is shown in charts. A numerical design example of optimum swirl atomizer is worked out. A nondimensional empirical formula is given for the surface-volume mean drop diameter and the size-distribution function. K. J. DeJuhasz, Germany

532. Yamamoto, G., and Ohtake, T., Electron microscope study of cloud and fog nuclei. Part I. *Sci. Rep. Res. Inst. Tohoku Univ. Ser. 5, Geophysics* **5,** 3, 141–159, Dec. 1953.

Specimen changes due to electron bombardment in the electron microscopes were investigated on numerous artificially produced nuclei. Nuclei of different substances show changes characteristic of the respective substances. Using this result, the nature of fog nuclei captured in Sendai and of cloud nuclei on Mount Zao was investigated. Statistical results concerning nature and size of fog and cloud nuclei are described; nuclei of sea salt, of combustion products, and of soil particles were identified, and their size distribution represented in charts. Large number of electron micrographs of nuclei, before and after electron bombardment, are shown. Work of Japanese and European investigators is reviewed.

K. J. DeJuhasz, Germany

533. Tanasawa, Y., Sasaki, S., and Nagai, N., The atomization of liquids by means of flat impingement, *Technol. Rep. Tohoku Univ.* **22,** 1, 73–95, 1957.

Experimental study on atomization characteristics of flat, 180-deg impingement nozzles of various types. It has been found that the atomization occurs by film formation. On the basis of results a new type of impingement nozzle with flat spray and controlled flow rate is proposed for the open-chamber diesel engine. Experimental setup is illustrated and described; flow rate characteristics and discharge coefficients are determined. Flash photos of sprays with liquids of various viscosities are shown. Drop-size distribution mean drop size, and penetration of sprays are shown in charts. Drawing of a proposed impingement nozzle is given.

K. J. DeJuhasz, Germany

534. Poulston, B. V., and Winter, E. F., Techniques for the study of air flow and fuel droplet distribution in combustion systems, Sixth (International) Symposium on Combustion, New York, Reinhold Publ. Corp., 1957, 833–842.

Research into the fundamental processes of liquid fuel combustion concerns itself with homogeneous systems of idealized droplet systems to obtain basic combustion data. Actual combustion equipment uses far more complex systems. The techniques described in this paper deal with separate investigations of component processes of combustion systems, namely: flow pattern, fuel distribution, sizes of droplets produced by an atomizer. Air flow can be studied, with and without combustion, by a water-cooled three-dimensional pitot tube. Flow pattern can be studied in a water model by continuous light and by electronic flash. Residence time of a particle in any zone of the combustion chamber can be studied by injecting a single tracer particle of polystyrene globule with fluorescent coating, illuminated by ultraviolet light from a mercury discharge lamp, and photographing the trace in a time exposure. Fuel spray distribution can be studied by probes protruding into the spray for collecting the spray; the location of the probe entrance can be varied both axially and radially. These component factors and phenomena can be correlated with the actual combustion, and conclusions drawn for the effect of each factor on the efficiency of combustion.

K. J. DeJuhasz, Germany

535. Tanasawa, Y., Sasaki, S., and Nagai, N., A study of impingement nozzles for diesel engines, *Technol. Rep. Tohoku Univ.* **22,** 2, 153–172, 1958.

The impingement nozzle has good atomizing characteristics, and can give various shapes of spray. Effects of various forms and dimensions of impingement nozzles are examined systematically. Nozzles with oblique impingment angles are tested and a design is proposed for an automatic, multi-hole, oblique-impingement nozzle for diesel engine use. Another design, with a single orifice and an impingement target plate fitted into the engine piston, is also shown. The atomization characteristics of these two new types of nozzles, and the drop-size vs. impingement velocities have been determined. A large number of photos showing the breakup of the liquid sheet into drops under various conditions are included. The investigation was carried out with the aid of the Toyota Motor Car Company. K. J. DeJuhasz, Germany

536. Bindermann, W., Development of a device for the direct measurement of the injection characteristics of diesel engine fuel injection systems (in German), *Kraftfahrzeugtechnik* **7,** 11, 409–416, 1957.

An important characteristic of the injection system of diesel engines is the rate of discharge, i.e., the amount of fuel injected per degree of crankshaft rotation. This rate depends on the rate of delivery of the pump, the dimensions of the injection tubing, and the characteristics of the nozzle; it also depends, in a given injection system, on the quantity-rack setting and the engine speed, and to a lesser degree on the properties of the fuel. The rate of discharge can be calculated approximately but the actual values can be determined only experimentally. Previous devices for this

purpose are critically examined, and a "cell-wheel" developed at author's institute and based on strobometric procedure, is illustrated, described and some test results given. The nozzle injects into separate container tubes arranged around the periphery of a rotating drum; each container collects the amount discharged during a period corresponding to one-half degree of pump-shaft rotation; after a test extending over a known number of injections, the amounts in the separate container tubes are syphoned off into a series of glass measuring tubes where the heights of the liquid show the rate of discharge. The design requirements for the device, and the means whereby these were met, are fully explained.

K. J. DeJuhasz, Germany

537. Tanasawa, Y., and Toyoda, S., On the atomizing characteristics of injectors for diesel engines *Technol. Rep. Tohoku Univ.* **21**, 1, 117–145, 1956.

Characteristics of fuel spray having influence on the combustion in diesel engines are: (1) surface-volume mean diameter of drops, (2) distribution of drop size in spray, (3) dispersion of sprayed drops, (4) degree of distribution, (5) penetration, (6) rate of injection, (7) discharge coefficient of nozzle. Items (1) and (2), termed atomizing characteristics, have been investigated by authors by means of a very-short-time (10^{-7} sec) spark illumination, and by actual measurement of drops by the immersion liquid and by the molten-wax methods. Spark circuit ("Marx's circuit") and photographic arrangement are illustrated and described, and methods of measuring the injection pressure, timing, and needle lift explained. Photos of wax drops are shown, their separation into size groups explained. Characteristics of pintle and throttle nozzles are explained and illustrated. Impingement nozzle and swirl nozzle are shown, with new proposed modifications. Pressure diagrams of an actual diesel engine with a Saurer-type piston head with various types of nozzle are shown and compared.

K. J. DeJuhasz, Germany

538. Yamamoto, G., and Ohtake, T., Electron microscope study of cloud and fog nuclei. Part II. *Sci. Rep. Res. Inst. Tohoku Univ. Ser. 5, Geophysics* **7**, 1, 10–16, Aug. 1955.

Fog and mist nuclei collected at various places on different occasions were examined by electron microscope. Mist nuclei are mainly of sea salt crystals, while fog nuclei are mostly combustion products. There is evidence that large sea salt nuclei in clouds are prone to cause precipitation by accretion. Authors distinguish between fog and mist according to the visibility being smaller or greater than one kilometer. Size distribution of fog and mist nuclei and of fog and mist droplets are given in histograms, and the ratio of drop size to nucleus size is given in a table.

K. J. DeJuhasz, Germany

539. Ohtake, T., A study of cloud drops on the mountain, *Sci. Rep. Res. Inst. Tohoku Univ., Ser. 5, Geophysics* **9**, 1, 22–28, 1957.

Cloud drops were collected at various levels on a mountain and examined by electron microscope. Drops containing sea salt nuclei were found to be larger than those formed by other nuclei. At higher levels more salt nuclei of smaller size, and at lower levels less salt nuclei but of larger size were found. Salinity of water from clouds increases with height. This tendency is also observed in chlorinity of snow and rime collected in winter, and can be explained by the more rapid falling of the drops containing the larger salt nuclei. Reference is made to researches of other Japanese meteorologists, and of Woodcock and Blanchard's work on the salt-nuclei hypothesis of rain formation.

K. J. DeJuhasz, Germany

540. Kinzer, G. D., and Cobb, W. E., Laboratory measurements and analysis of the growth and collection efficiency of cloud droplets, *J. Meteor.* **15**, 2, 138–148, Apr. 1958.

Water drops initially 2 micron in radius were held stationary for observation in an upward streaming cloud and were found to grow by accretion. The rate of increase of radius of individual drops was measured from 4 to 65 micron. Experimental collection efficiencies obtained from the data agree within limits of experimental error with those calculated from theory that is developed from intuitive physical arguments which are based on a superimposed random motion observed in the fall of drops in the supporting cloud. The theory implies that a small-scale eddy diffusion transfers smaller drops from the parent cloud to the growing drop. Coefficient of drop transport calculated from the theory agrees well with one evaluated experimentally. Past measurements of drops growing by accretion from 100 to 1500 micron in radius have been combined with results of present investigation in order to compare the efficiencies calculated by the new theory with measured values over a more extensive range. The parent cloud had a temperature of 22 C, and a free water content of 3.5 grams/m^3. Two types of distributions were used: one with 80 per cent of the free water content in drops 5.5 to 8.0 micron radius, and the second with the free water distributed more widely among drops 3.9 to 10.4 micron radius. The droplets of the parent cloud were produced by atomization of water and were randomly electrified to a magnitude similar to that measured on drops in natural cumuliform clouds. It is shown that the electrification was too small to produce dynamic effects of more than one-tenth of the order of magnitude of those by the eddy transfer, although coalescence may be promoted by electrical forces whenever eddy diffusion transports droplets to within 2 or 3 micron of the growing drop. Experimental apparatus is described and schematically illustrated; mathematical methods are described in detail; work of previous investigators is critically discussed.

K. J. DeJuhasz, Germany

541. Reman, G. H., The countercurrent flow of two immiscible liquid phases (capacity of spray extraction columns) (in Dutch), *Ingenieur* 45, 128–133, 1957.

A derivation is given of equations and correlations describing the countercurrent flow of two immiscible liquid phases. It is based on (1) the assumption that the Weber number relation holds good for the size of droplets in the countercurrent flow of these two phases, (2) the relationship for the relative velocity of particles in "particulate" fluidization of solids with liquids. The equations and correlations have been applied to extraction columns, and these were found to give a good description of (1) the hold-up of the dispersed phase under flooding conditions, (2) the maximum flow rates. The relations found are represented in numerous graphs. Various liquid systems are listed in table, giving density, viscosity and interfacial tension of the two phases. Analysis is carried out for a 4-in. diam spray extraction column but is claimed to be valid also for columns of smaller and larger diameter.

K. J. DeJuhasz, Germany

Porous Media

(See also Rev. 280)

542. Shea, P. H., and Whitsett, H. E., Predicting seepage under dams on multi-layered foundations, *Proc. Amer. Soc. civ. Engrs.* **84**, SM 3 (*J. soil Mech.*), Pap. 1727, 42 pp., Aug. 1958.

Determination of discharge and effects of seepage under dams and levees may be accomplished simply when foundation is formed by simple pervious layer. When foundation is blanketed by relatively impervious layer, seepage may be computed or derived from a flow net, if difference in permeabilities is not too great. When more than one layer is present, construction of flow net is impractical. After discussing usual conditions for flow computation, authors describe pumping tests and computation of

discharges for three cases: one aquifer and one blanket; two aquifers and two blankets; three aquifers and three blankets. Equations are presented. Comparison between computed and measured discharges shows that prediction of discharges may at least give the order of magnitude of real flow. Some experiments showed very erratic results when compared with theoretical computations. A. Balloffet, USA

543. Orlob, G. T., and Radhakrishna, G. N., The effects of entrapped gases on the hydraulic characteristics of porous media, *Trans. Amer. geophys. Un.* **39,** 4, 648–659, Aug. 1958.

Investigation of the hydraulic characteristics of prepared porous media indicate that a 10% increase in air content of media voids is capable of producing a 15% reduction in "effective porosity," a 35% decrease in permeability, and about 50% reduction in hydraulic dispersion. The location of bubbles in large or small pores affects the uniformity of pore sizes and determines the amount of water-saturated void volume which is isolated by air bubbles. The shape of the chloride tracer "breakthrough" curve is greatly modified by changes in uniformity of pore size. An appreciation of the effects of gas accumulation is essential to a proper interpretation of the hydraulic behavior of natural formations. From authors' summary

544. Woodside, W., and Kuzmak, J. M., Effect of temperature distribution on moisture flow in porous materials, *Trans. Amer. geophys. Un.* **39,** 4, 676–680, Aug. 1958.

Several experimenters have observed moisture flow rates through porous materials under a temperature gradient which are many times the calculated rates based on vapor diffusion. To investigate this discrepancy, a temperature gradient was applied across an enlarged model of a particular, high-quartz wet sand, and the temperature distribution within the pore spaces was measured. For the "air-dry condition" of the model, the average temperature gradient in the pore spaces was six times the over-all applied gradient. Approximately this same ratio exists, therefore, between the respective vapor pressure gradients.

It is proposed that the flow mechanism consists of multiple vapor diffusion and liquid flow steps in series, the resistance to flow in the liquid phase being negligible, so that the flow rate is determined by the vapor pressure gradients in the pore spaces. The fact that these gradients are of the order of six times the overall gradient previously used to calculate the flow rate at least partially explains the discrepancy.

From authors' summary

545. Hollingsworth, B. J., and Meyer, H. I., Two-dimensional gravity drainage profiles, *Trans. Amer. geophys. Un.* **39,** 4, 689–696, Aug. 1958.

Authors study shape of the fluid-fluid interface of a liquid under gravity draining from a saturated porous medium. The classical potential theory solution is put into a form amenable to use by a digital computer, and some discussion of the numerical methods employed is given. The results of a series of numerical solutions are used to define an area function which is employed, along with the mass balance concept and the idea of a succession of steady states, to derive an expression for transient drainage from a two-dimensional saturated medium. This transient solution is compared with the actual drainage rate from a Hele-Shaw analog system. G. Power, England

546. Irmay, S., On the theoretical derivation of Darcy and Forchheimer formulas, *Trans. Amer. geophys. Un.* **39,** 4, 702–707, Aug. 1958.

The Darcy and Forchheimer formulas, together with extensions, are reviewed, and their validity examined in some detail.

G. Power, England

547. Saffman, P. G., and Taylor, G., The penetration of a fluid into a porous medium of Hele-Shaw cell containing a more viscous liquid, *Proc. roy. Soc. Lond.* (*A*) **245,** 1242, 312–329, June 1958.

The interface between two fluids in a porous medium is shown to be unstable when movement occurs from the less viscous to the more viscous fluid and the velocity exceeds a certain limiting value. The instability takes the form of round ended fingers of less viscous fluid penetrating into the more viscous one, familiar in oil technology as "water tonguing or coning." The analysis shows that a flow is possible in which equally spaced fingers advance at constant velocity (U).

Experiments using a Hele-Shaw analog were made to produce single fingers. These showed that unless the flow was very slow, λ = (width of finger)/(spacing of fingers) was close to $\frac{1}{2}$, a result which has not so far been explained. As the speed decreased to zero, λ increased from $\frac{1}{2}$ to unity. Experiments using air or water as the less viscous fluid penetrating oils of different viscosity (μ) showed that λ was a function of $\mu U/T$, where T was the interfacial tension. G. H. Lean, England

548. Munier-Jolain, J. P., Well output (in French), *Rev. Inst. fr. Petrole et Ann. Comb. liq.* **13,** 1, 46–53, Jan. 1958.

Article seeks to draw a parallel between the production characteristics of a well tapping a water-bearing stratum and those of an oil or gas well.

This has led the author to study the influence on the output of a well of the variations in permeability through the horizon tapped, on the one hand, and, on the other hand, the influence of the differences between the geometry of the bed and the assumptions as to circular radial drainage on which the laws of flow are based.

From author's summary

549. Yuan, S. W., Turbulent flow in channels with porous walls, Polyt. Inst. Brooklyn. Aero. Lab. Rep. 407, 13 pp., Aug. 1957.

Author writes out the rather lengthy equations resulting from the application of the Prandtl-von Karman momentum-transfer theory to a special case of flow in a porous-walled channel. He claims no data are available to check his solutions. Reviewer finds this surprising, since both Weissberg and Berman [AMR **10** (1957), Rev. 501] and Eckert et al. [AMR **8** (1955), Rev. 1737] report measurements of velocity profiles for turbulent flow in porous-walled channels. If author's case is too specialized to handle these data, it has little engineering significance.

R. R. Hughes, USA

550. Arkhangel'skii, V. A., Flow of vaporizing liquids in the hydraulic system of reservoir and well (in French), 9th Congrès intern. Mécan. appl., Univ. Bruxelles, 1957; **2,** 235–243.

Author develops equations relating static head, frictional pressure drop, vapor-liquid equilibrium, and holdup, for a well producing both gas and oil. These show that, for a given gas-liquid production ratio, the bottom-hole pressure passes through a minimum as total flow rate increases. As an example, a few measurements are reported on one well. Reviewer thinks author's application of general principles is correct and straightforward, but also quite elementary. Emphasis should have been placed on the experimental results and their significance. Several typographical errors appear in the equations. R. R. Hughes, USA

551. Zinovieva, L. A., Methodology of the hydrodynamic analysis of the gas factor in petroleum fields worked in dissolved-gas conditions (in Russian), *Trudî Vses. neftegaz n.-i. in-ta* no. 8, 323–332, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3297.

A method is explained for the approximate calculation of the averaged (over the stratum) values of petroleum saturation, values of the gas factor, and values of the petroleum yield of deposits of

gaseous petroleum in the conditions of a dissolved gas. An example is given of the evaluation of field data, enabling evaluation of the degree of accuracy of the values of the gas factor obtained by calculations starting from the averaged values of the pressure and degree of petroleum saturation. It would be exceedingly interesting also to evaluate the averaged values of the said values, as well as the time of exhaustion of the deposit, as obtained by solution of the corresponding equations given in this paper.

V. A. Arkhangel'skii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

552. Mironenko, V. T., The calculation of the discharge flows from a rectilinear battery of boreholes (in Russian), *Trudi Mosk. Neft. in-ta* no. 16, 82–85, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3275.

The question is discussed of the discharge from a rectilinear battery of boreholes of finite length. In approximation, the problem can be resolved into the analysis of a linear equation in finite differences of the second order, the general solution whereof is obtained with the help of the corresponding characteristic equation. Utilizing known methods of averaging, author deduces the approximate formulas for the total discharge volume from the boreholes of a rectilinear battery. The results are compared with some analogous data known from the researches of other authors.

V. P. Pilatovskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

553. Mkhitaryan, A. M., The calculation of the filtration through inhomogeneous earth dams on a permeable foundation (in Russian), *Trudi Kuybyshevsk. inzh.-stroit. in-ta* no. 3, 65–79, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3274.

An approximate method is presented for calculating the filtration through earth dams erected on a permeable foundation, and equipped with impermeable or only slightly permeable sills and cores without drainage to the downstream slope.

The allowance for the loss of head within the upstream and downstream wedges is made by the method of N. N. Pavlovsky. The streamlines at entry to and exit from the region of the permeable foundation are assumed to be concentric circles (according to the method of Billdyug). To determine the depth of the filtration flow on the crest of the sill, the Cozeny formula is used.

Examining separately the motion of the flow through the body of the dam and through the permeable foundation (by the Dupuy equation), author obtains a number of complex relationships for determining the necessary elements characterizing the motion of the filtration flow.

The presence of very material assumptions enables the suggested analysis to be regarded as only a very rough approximation, the degree of accuracy of which is quite indeterminate.

A. A. Uginchus

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

554. Nelson-Skornyakov, F. B., Filtration through a dam with a drainage berm on an impermeable and permeable foundation (in Russian), *Gidrotekhn. str-vo* no. 5, 28–30, 1956; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3273.

A relationship already established by the present author by approximation, between the filtration flow Q and the permeation to the slope of the drainage term y_0, for the case of an impermeable foundation, as well as an expression for determining the magnitude of Q, is discussed. It is recommended to plot the depression curve by a quadratic parabola.

For a dam on a permeable foundation (the permeability of the foundation does not exceed the permeability of the dam), the flow is determined by dividing into sections with and without a hydraulic head, the flow through the first region being evaluated as for the case of filtration under a flume-bed. The depression curve and the permeable section are, in such case, to be determined in the same manner as for a dam on an impermeable foundation. The author quite correctly remarks that this method leads to a slight over-valuation of the ordinates of the depression curve.

It is suggested to determine the discharge velocities on the drainage bed by the somewhat cumbersome formula of N. N. Pavlosvky, obtained for the case of a flow around the flume-bed. It should be noted that this method leads to an under-estimation of the values of the discharge gradients.

V. M. Shestakov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

555. Efleev, A. P., The flow of petroleum to wells in deposits close to circular forms (in Russian), *Uch. zap. Kuibyshevsk. gos. ped. in-ta* no. 14, 109–116, 1956; *Ref. Zh. Mekh.* no. 4, 1957, Rev. 4478.

An investigation of the influence of displacement of a well on the discharge of the latter with draining of feed regions which are nearly circular.

V. A. Karpychev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

556. Borisov, Yu. P., The rational displacement of petroleum wells in a band deposit (in Russian), *Trudi Vses. neftegaz. n.-i. in-ta* no. 8, 66–113, 1956; *Ref. Zh. Mekh.* no. 4, 1957, Rev. 4477.

Author examines problem of the rational displacement of a series of operational wells in a band-shaped deposit of infinite dimensions. It is assumed that the seam is homogeneous as regards its physical properties; water pressure conditions obtain; the wells work at a given identical pressure.

By rationality of displacement of the operational well on a petroleum seam is understood the displacement which insures a minimum time for exploiting the deposit by a given number of wells.

A mathematical solution of the problem is given as well as a nomogram which speeds up the calculation.

G. L. Govorova

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

557. Barenblatt, G. I., Some problems of unsteady filtration (in Russian), *Izv. Akad. Nauk SSSR, Otd. tekh. Nauk* no. 6, 97–110, 1954; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3278.

This supplements earlier papers by the same author, [*Prikl. Mat. Mekh.* **16,** no. 1, 1952]. Approximate solutions are given of the Boussinesq equations for the case of unidimensional (plane and axially symmetrical) unsteady filtration of a liquid in a semi-infinite, pressureless and homogeneous stratum in the absence of liquid in the stratum at the initial time instant, and with varying head or flow of the liquid at the interface, according to a predetermined time law. Differing from the earlier papers, the functions entering into the simulated solutions are standardized in a somewhat different manner. Detailed tables of the said functions are given, as well as a series of supplementary values.

S. N. Numerov

Courtesy of Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

558. Paria, G., Axisymmetric consolidation for a porous elastic material containing a fluid, *J. Math. Phys.* **36,** 4, 338–346, Jan. 1958.

Paper deals with an elastic porous material containing a compressible fluid. M. A. Biot has proposed a theory of deformation and has established the equations for the general three-dimensional problem [AMR **9** (1956), Revs. 602 and 2778). Author, in this paper, studies the problem of the axisymmetric deformation for a semi-infinite medium loaded by surface forces and, using cylindrical coordinates and with the help of Laplace-Hankel transforms, solves the equations of the problem.

As an illustration of the calculation of stresses, the axial normal stress is evaluated in detail and the case of a concentrated force is considered. G. Sestini, Italy

559. Turiev, K. V., Application of radioactive isotopes in hydraulic engineering (soil investigation, seepage, discharge measurement) (in Russian), *Gidrotekh. Stroit.* **26,** 11, 67–72, Nov. 1957.

560. McCarty, D. G., and Peaceman, D. W., Application of large computers to reservoir engineering problems, *J. Petr. Technol.* **9,** 10, 14–18, October 1957.

561. Verigin, N. N., Drainage under a dam (formula for depression curves) (in Russian), *Gidrotekh. Stroit.* **26,** 8, 30–33, Aug. 1957.

Geophysics, Hydrology, Oceanography, Meteorology

(See also Revs. 116, 195, 309, 401, 402, 510, 538, 540)

Book—562. Ewing, W. M., Jardetzky, W. S., and Press, F., Elastic waves in layered media, New York, McGraw Hill Book Co., Inc. (Series in Geological Sciences), 1957, xi, + 380 pp. $10.

Some idea of the content of the book may be obtained from chapter titles which are:

I. Fundamental equations and solutions, 18 pages.
II. Homogeneous and isotropic half space, 37 pages.
III. Two semi-infinite media in contact, 47 pages.
IV. A layered half space, 114 pages.
V. The effects of gravity, curvature, and viscosity, 22 pages.
VI. Plates and cylinders, 38 pages.
VII. Wave propagation in media with variable velocity, 30 pages.

The distribution of material is indicated by the number of pages shown for each chapter.

The book might well have been presented as a monograph based on chapter IV, the longest chapter by far. The authors apparently added the other chapters in an attempt to provide a self-contained treatise on the subject. While the book is noteworthy as one of the few analytical works on this phase of geology in English, reviewer questions the value to the reader of much of the work outside of chapter IV. Either the reader is informed in these matters, in which case it is superfluous, or he is a beginner and the presentation is too embryonic and nonuniform. For example, in chapter I an effort is made to give an introduction to elasticity in Cartesian coordinates. The only distinguishing feature is that the authors anticipate the simultaneous discussion of problems in both fluids and solids by introducing the "total or material" rate of change operator (d/dt) and reserve the operator $(\partial/\partial t)$ for local rate of change. The material of this chapter is much better done in several well-known texts and treatises.

The bibliographies at the ends of the chapters are extensive and probably very useful. A considerable amount of physical data is given in terms of curves, tables, and seismograms. These should prove very interesting to the reader. The function of chapters V, VI, and VII can only be to show that certain problems exist. Conceming aeolotropic media, only two pages are included at the end of the book. Finally, there are two short appendices; one is on the method of steepest descent and the other is on Rayleigh's principle. W. H. Hoppmann, II, USA

563. Adams, W. M., A study of earthquake mechanism using S wave data, *Bull. seism. Soc. Amer.* **48,** 3, 201–219, July 1958.

Study of longitudinal waves recorded at many stations gives two solutions for the ground motion at the source. Transverse waves have rarely been used for this purpose, since they are recorded in an already disturbed portion of a seismogram, and since the theory involved in the combination of the two components, purely horizontal and in the plane of propagation perpendicular to the ray, complicates their use. A new method is suggested to find the line of the slip vector on the basis of the observed transverse waves. B. Gutenberg, USA

564. Sato, Y., Attenuation, dispersion, and the wave guide of the G wave, *Bull. seism. Soc. Amer.* **48,** 3, 231–251, July 1958.

G-waves are seismic surface shear waves over 100 km long. G-waves which had travelled up to four times around the earth in two major earthquakes showed nearly constant group velocities of 4.4 km/sec. If the amplitude decrement is given by $\exp(-\pi D/QVT)$, where D is the distance in km, V the velocity in km/sec, T the period in sec, $1/Q$ was found to decrease from about 15×10^{-3} for $T = 360$ sec to 5×10^{-3} for $T = 50$ sec. The G-waves correspond to Love waves travelling in the mantle which are controlled by the gradient of the shear velocity.

B. Gutenberg, USA

565. Housner, G. W., The mechanism of sandblows, *Bull. seism. Soc. Amer.* **48,** 2, 155–161, Apr. 1958.

The formation of sandblows by earthquakes is explained in terms of well-known properties of water-bearing soils. The important parameters of the problem are the porosity, the permeability, the elasticity, and the degree of consolidation of the soil. The important conditions are that the water table be sufficiently near the ground surface and that the readjustment of soil particles by the passage of seismic waves be of sufficient magnitude.

From author's summary

566. Stassi D'Alia, F., The theory of plasticity and the formation of continents and mountain reliefs (in Italian), *Ric. sci.* **28,** 3, 575–592, Mar. 1958.

Author shows the applicability of a limiting condition of yielding he suggested to the materials composing the earth crust, submitted to high stresses which determine displacements of material. In the present article he analyzes the formation of continents and mountains, the surface cracks of the earth crust, the formation of salt domes, considering the masses of material involved under the aspect of plastic masses flowing under the effect of stresses of particularly high intensity.

From author's summary

567. Carrier, G. F., and Greenspan, H. P., Water waves of finite amplitude on a sloping beach, *J. Fluid Mech.* **4,** 1, 97–109, May 1958.

Authors use nonlinear inviscid shallow water wave theory to investigate the behavior of a wave as it climbs a uniformly sloping beach. Fundamental equations of motion and continuity are transformed by method of characteristics [Stoker, *Comm. Pure Appl. Math.* **1,** no. 1, 1948] to single linear second-order equation, whose solution in terms of parametric functions yields horizontal velocity $v(x, t)$ and surface elevation $\eta(x, t)$. Explicit solutions are obtained by selecting wave forms of physically interesting type, confined to forms of potential function for which it is shown the waves will not break on the sloping boundary (η and v single-

valued). An initially recessed surface, declining pseudo-exponentially seaward from maximum amplitude at the shore, is shown to rise above mean sea level up the slope and settle slowly back to equilibrium level without further oscillation. Another example taken is that of an initially superelevated surface of steep front compared to the rear which declines exponentially seaward. This is shown to rise up the shore on reaching the coast then fall away below mean sea level before slowly returning to equilibrium level without further oscillation. Authors state that no general criteria had yet been found by them to determine when a given wave will break. B. W. Wilson, USA

568. Ishiguro, S., An electronic method for recording and analysing ocean waves, Part I: An electronic system for recording and analysing sea waves, *Oceanogr. Mag.* **9,** 2, 159–207, Dec. 1957.

Author describes in detail the theory and design of two types of wave recorders and an analog spectrum analyzer.

One wave recorder, similar in shape to a spar buoy, utilizes as the wave detector a long buoyant cylinder whose motion relative to the main supporting buoy is partially restrained by springs. The cylinder motion is transmitted by mechanical linkage to a recording mechanism. Reviewer questions accuracy of the theory of the buoy's motion, or response characteristic, as author does not use as pressure on the buoy the hydrodynamic pressure from the wave field but simply a hydrostatic pressure varying sinusoidally. A significant and undesirable change in response characteristic very likely will result if correct pressure is used. Author does not discuss experience in actual use of instrument, whether as free floating buoy or anchored buoy. Unless instrument is attached to some rigid platform, reviewer questions usefulness or accuracy of data. The other instrument described is the more familiar pressure-type wave recorder which uses a sensitive pressure transducer as sensing element.

Author concludes with discussion on design and operating characteristics of a heterodyne-type analyzer and uses as filter a tuning fork of 6KC/s. Input may be through a magnetic disk on which the original data has been recorded and which on playback is speeded up 225 to 600 times, depending on time scale of original data. An alternative optical input is available for use of film or white paper tape with variable blackened areas. Output is the Fourier amplitudes of the harmonics of fundamental period.

Reviewer believes main value of paper lies in description of the spectrum analyzer. H. G. Farmer, Jr., USA

569. Jasper, N. H., Statistical distribution patterns of ocean waves and of wave-induced ship stresses and motions, with engineering applications, *David W. Taylor Mod. Basin Rep.* 921, 59 pp., Oct. 1957.

570. Miller, F. B., Dynamic wave-height recorder type 286-1A, *David W. Taylor Mod. Basin Rep.* 1123, 10 pp. + 8 figs. + refs., Aug. 1957.

Report describes a dynamic wave-height recording system which utilizes an insulated wire probe as a capacitance-type transducing element. The electronic portion of the system is designed as a plug-in component of a commercial direct-writing recorder console. The output of the system is in the form of a rectangular plot of wave height versus time. Schematic diagrams and operating instructions are included.

From author's summary

571. Timonov, V. V., Activities of the State Hydro-Meteorological Service in regard to methods of current and tide research (in Russian), *Trudi Gos. okeanogr. in-ta* no. 30, 3–9, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3088.

Paper constitutes a preface to the summary of work on the methods of experimental investigation of ocean currents and tidal phenomena. A brief description is given of the experimental equipment created by Soviet research workers for this purpose. The fundamental experimental programs in current and tidal research during the past 20 years are surveyed. In addition, the contents of the papers reproduced in the summary, and an evaluation of the experimental results obtained, are given.

N. N. Moiseev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

572. Kao, S.-K., Planetary waves and jet streams in the atmosphere, *Trans. Amer. geophys. Un.* **39,** 4, 620–623, Aug. 1958.

An analytical wave solution of two-dimensional barotropic vorticity equation is obtained in the case of a basic zonal current with jet stream. Author concludes that the phase velocity of wave increases with narrowing of the jet stream, and that the dimension of planetary wave increases with broadening of the jet stream. It is of interest that under the assumption of timely constant velocity shear superposed on the zonal current, the resulting amplitude of wave solution is damped out irrespective of the sign of shear. Further, treating the motion on a spherical earth with uniform angular velocity, the resemblance of flow pattern in the theoretical and in the actual atmosphere is demonstrated.

K. Miyakoda, Japan

573. Hansen, C. F., Some characteristics of the upper atmosphere pertaining to hypervelocity flight, *Jet Propulsion* **27,** 11, 1151–1157, Nov. 1957.

In an introductory summary on the photochemistry of the atmosphere paper discusses: temperature and density distribution with altitude (up to 250 miles) based on recent measurements made from rockets; airglow and auroral phenomena, providing at present most of the useful clues to the chemical state of the upper atmosphere (thus, for instance, the emission from hydroxyl radicals included in the airglow shows that water vapor exists at very high altitudes); some observations on nitrogen reactions, about which little is understood today; a more detailed description of the photochemistry of oxygen in the different layers of the atmosphere. On the whole, the predominant reactions responsible for the solar energy absorption are outlined and the major rate-controlling reactions which determine the atmospheric state of chemical equilibrium are described.

In the following section the three regions of continuum flow, slip flow, and free molecular flow are described, and it is shown that above 60 miles (the lower bound of the slip-flow regime for the typical vehicle flying up to escape velocity) the aerodynamic force and heat-transfer effects become secondary. In the slip-flow regime, however, there is a region of maximum possible erosion rates originating in the high-energetic molecular bombardment of the vehicle.

Meteor and cosmic particle problems and other hazards at high altitudes are discussed in a final chapter, and it is concluded that "manned flight into the upper altitudes seems definitely feasible and rather moderate extensions of our present knowledge should be sufficient to make the attempt practical."

H. Behrbohm, Sweden

574. Sanuki, M., Kimura, S., and Kato, H., Time constant of a monoplane wind vane of which the moment of inertia and arm length are systematically changed, *Pap. Meteor. Geophys.* **8,** 3, 232–235, Oct. 1957.

575. Nan'niti, T., Eulerian correlation of temperature in the atmosphere and oceans, *Pap. Meteor. Geophys.* **8,** 3, 236–240, Oct. 1957.

Tomoda's method for calculating the correlation coefficients $R(t)$ has been applied to temperature analysis in the atmosphere and oceans. The results show that the temperature fluctuations

are caused by turbulence $m = 4/3$, diurnal variation $m = 2$, and some factor related to temperature durability $m = 1$, being represented $R(t) \sim 1 - (t/T_0)^m$. The maximum passage time of turbulence was $T_0 = 30$ hr. From author's summary

576. Press, H., Atmospheric turbulence environment with special reference to continuous turbulence, *AGARD Rep.* 115, 29 pp. + appendix, Apr./May 1957.

The flight-test techniques for measuring continuous atmospheric turbulence are briefly outlined and available measurements of the power spectrum of atmospheric turbulence reviewed. The measured results are examined in order to determine how well they approximate the idealized models of a stationary Gaussian random process and of isotropic turbulence. Finally, some recent results on the variation with altitude of the probability distribution of the root-mean-square gust velocity are presented and the application of these results to operational response history calculations indicated. From author's summary

577. Hutchings, J. W., The correlation between wind and atmospheric pressure, *J. Meteor.* **14,** 6, 566–569 (Shorter Contributions), Dec. 1957.

578. Uchastkin, P. V., Method of local creation of given meteorological conditions with the aid of "a descending flow" (in Russian), *Trudi nauch. sessii Vses. n.-i. in-ta okhrany truda* 1954, no. 1, 9–15, 1955; *Ref. Zh. Mekh.* no. 4, 1957, Rev. 4188.

An experimental investigation of artificial cooling of an air medium at working positions by the "method of a descending flow" is performed in which a cooled air jet of large diameter and a small rate of flow is fed from top to bottom of the working position. The results of measurement of the field of temperatures and velocities in this jet, which has an initial diameter of 800 mm, are given. G. L. Grodzovskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

579. Starr, V. P., and Peixoto, J. P., On the global balance of water vapor and the hydrology of deserts, *Tellus* **10,** 2, 188–194, May 1958.

Horizontal divergence of vertically integrated moisture flux over Northern Hemisphere is computed for 1950. Maxima of divergence are found over certain oceanic regions and over some deserts. Latter implies unexpectedly large evaporation over deserts. Authors speculate on possible sources of this moisture; surface flow from adjacent regions, ground water flow.

W. P. Elliott, USA

Naval Architecture and Marine Engineering

(See also Revs. 206, 207, 591)

580. Vossers, G., The first international symposium on the behaviour of ships in a seaway, *Inter. Shipbldg. Progr.* **4,** 38, 551–558, Oct. 1957.

Author gives a very concise, but highly informative, summary of the 46 papers which were presented at the subject Symposium. This survey of the material in these many interesting papers is a welcome addition to the volume of 800 pages which was prepared in advance of the Symposium. J. P. Breslin, USA

581. Babaev, N. N., The contemporary position and development of the problem of ship vibration (in Russian), *Sudostroennie* no. 3, 4–10, 1956; *Ref. Zh. Mekh.* no. 1, 1957, Rev. 609.

A short review of the development of the theory of ship vibration, and also of the experimental remedies, making it possible to obtain experimental material and to put forward the problem of ship vibration prevention by means of rational methods of hull construction and of equipment, even in the early stages of planning. A. N. Shmyrev

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582. Gerritsma, J., Experimental determination of damping, added mass, and added mass moment of inertia of a ship model, *Inter. Shipbldg. Progr.* **4,** 38, 505–519, Oct. 1957.

Author reports experimental results obtained from experiments on a Series 60 model having a block coefficient of 0.6. The results are obtained by solving for the coefficients the well-known linear second-order ordinary differential equations of motion for pure heaving, pure pitching, and combined heaving and pitching. The results given show that a great many tests were conducted, thereby giving very definite experimental curves for the variation of damping, added mass, and added mass moment of inertia as a function of applied frequency and forward speed Froude number. Author correctly points out that the results at low Froude numbers and low frequencies are not reliable because of reflections from the tank walls. This fact unfortunately precludes a good determination of the dependence of these factors upon Froude numbers. The data indicated that for Froude numbers in the range 0.15 to 0.30 there is presumably a mild variation in the various coefficients with Froude number and, hence, presumably no large variation will be found between the range Froude number 0 to 0.02. Two important results appear, viz., coupling terms are not negligible; use of linear differential equations may be required as good approximations in treating the motions within the amplitude range of the experiments. J. P. Breslin, USA

583. Chudinov, S. D., The lifting force of a hydrofoil of finite span (in Russian), *Trudi Vses. nauch. inzh. -tekh. o-va sudostr.* **6,** 2, 74–92, 1955; *Ref. Zh. Mekh.* no. 3, 1957, Rev. 3023.

The relationship is elucidated between the lift coefficient of the hydrofoil and the parameters characterizing the form and attitude of the profile relative to the surface of the liquid and the incident flow parallel thereto. Assuming the profile to be thin and with small curvature, and the flow around it streamlined, the angle of incidence small, the pressure distributions on the upper and lower surfaces independent of each other, while the pressure distribution on the lower surface is independent of the immersion, the author obtains an approximate expression for the lift coefficient of a hydrofoil of infinite span.

Author approaches the problem of the hydrofoil of finite span from the hypothesis of flat sections. The hydrofoil is substituted by a rectilinear segment along which the induced velocities are assumed to be equal. From this segment, in the direction toward the incident flow, there extends an infinite surface of discontinuous velocity, the width whereof equals the span of the hydrofoil. Further, the potential flow of an imponderable fluid in a plane perpendicular to the velocity vector, produced by the action of the instantaneous pressure impulse forces, is examined. To satisfy the boundary condition on the free surface, which is regarded as of small curvature, the characteristic function $\nu = \phi + i\psi$ is analytically extended into the upper semi-surface above the unperturbed, free surface. As a result, a flow pattern is obtained, similar to the flow around a biplane wing.

Applying the theorems of impulse and energy, author succeeds in obtaining expressions for the lifting force of the hydrofoil, and the angle of obliquity of the flow across the associated mass of the biplane. In view of the symmetry of the flow, with reference to the free surface, this mass can be assumed equal to the associated mass of a unit plate λ, situated at double the depth of immersion of the hydrofoil. The determination of λ is effected by means of experimental data. In the concluding section, formulas are given for calculating the lifting force of a wing (hydrofoil) of

finite span, and the calculated results are compared with the experimental results of A. N. Vladimirov [*Trudī CAHI*, no. 31, 1937] which witness to satisfactory convergence.

M. G. Kulaev

Courtesy Referativnyi Zhurnal, USSR Translation, courtesy Ministry of Supply, England

584. Morgan, W. B., Propeller induction factors, *David W. Taylor Mod. Basin Rep.* 1183, 6 pp. + 7 tables, Nov. 1957.

Calculations have been performed for the induction factors of 2, 3, 4, 5, 6, 7 and 8-bladed propellers over a range of β_i from 5° to 80°. The results are presented in tabular form for both the axial and tangential induction factors.

From author's summary

585. McGehee, J. R., Effects of nose shape and spray control strips on emergence and planing spray of hydro-ski models, *NACA TN* 4294, 6 pp. + 6 figs., July 1958.

The emergence-spray characteristics of the models with various bow shapes were investigated for depths of submersion of the bow from 0.50 inch to −0.50 inch. The planing-spray characteristics of the models with the various deflectors were determined for a draft corresponding to a length-beam ratio of 4. This investigation was performed for trims of 12° and 20° at a speed of 30 feet per second. The emergence-spray and planing-spray patterns are shown in photographs. From author's summary

586. Firth, D., The history and development of hydraulic transmissions for marine propulsion, *N. E. Cst. Engrs. Ship. Trans.* **74,** 5, 285–310, Mar. 1958.

Friction, Lubrication and Wear

587. Bearing, lubricants and lubrication, *Mech. Engng., N. Y.* **80,** 9, 64–74, Sept. 1958.

The study of lubrication goes forward in the laboratories as engineering strives to meet the new problems of high temperature and corrosive environment. The paper is a digest of 1957 literature on the subject. From summary

588. Ball and roller bearing lubrication, *Lubrication* **44,** 8, 101–112, Aug. 1958.

589. Asch, A. B., Antifriction instrument-bearing torque testing and the resistance to motion of such bearings, ASME Semiann. Meet., Detroit, Mich., June 1958. Pap. 58-SA-34, 3 pp.

590. Jones, A. B., Ball motion and sliding friction in ball bearings, ASME-ARS Conf., Dallas, Texas, Mar. 1958. Pap. 58-AV-14, 39 pp.

Interfacial slip and therefore sliding friction can occur between the ball and race in the case of high-speed ball bearings. Both high pressures and inertia effects at high speeds bring about elastic deformations which cause larger contact areas and friction. Coulomb friction is, however, assumed. A method is established for determining the motion and sliding friction of the ball in an angular-contact bearing subjected to thrust loads. Eight equations, involving double integrals for which closed-form solutions cannot be found, must be solved simultaneously. Thus an iteration method using a high-speed computer is probably the best path to answers in a particular case. It is shown how the solution can be simplified by neglecting, where allowable, gyratory-moment effects. J. P. Vidosic, USA

591. Newman, A. D., Water-lubricated bearings for marine use, *N. E. Cst. Instn. Engrs. Ship. Trans.* **74,** 7, 357–370, May/June 1958.

592. Rao, M. R. K., and Murthy, K. N., Influence of load on liner temperature and wear in a high-speed diesel engine, *J. Indian Inst. Sci. (B)* **40,** 1, 1–10, Jan. 1958.

Wear tests conducted with high-speed diesel engines indicated that engines running on varying loads suffered more wear than engines running on full load most of the time. It was suspected that the increased wear was due to increased corrosion caused by low liner temperatures at part-load conditions. To verify this, liner temperatures were measured in a single-cylinder high-speed diesel engine run at various loads, coolant outlet temperatures, and rates of coolant circulation.

It is concluded from these experiments that, for the coolant outlet temperatures currently employed in high-speed diesel engines, the liner temperature will be low enough at part loads to cause increased corrosive wear. This can be countered by employing coolant temperatures of the order of 105–110 C which can be obtained in a closed-cycle coolant system by moderate pressurisation of 5–10 psig. From authors' summary

Books Received for Review — January 1959 Issue

BERS, L., Mathematical aspects of subsonic and transonic gas dynamics, New York, John Wiley & Sons, Inc., (Surveys in Applied Mathematics, Vol. 3), 1958, xv + 164 pp. $7.75.

BEYER, R., Kinematisch-getriebeanalytisches Praktikum, Berlin, Springer-Verlag, 1958, vii + 172 pp. DM 28.50.

BOWER, J. L., and SCHULTHEISS, P. M., Introduction to the design of servomechanisms, New York, John Wiley & Sons, Inc., 1958, xi + 510 pp. $13.00.

DE BRUIJN, N. G., Asymptotic methods in analysis, New York, Interscience Publishers, Inc., 1958, xii + 200 pp. $5.75.

DERESIEWICZ, H., Elements of engineering statics, New York, Columbia University Press, 1958, vi + 124 pp. $3.50.

DOETSCH, G., Einfuhrung in Theorie und Anwendung der Laplace-Transformation, Basel, Birkhauser Verlag, 1958, 301 pp. Fr. 39.40.

DURELLI, A., PHILLIPS, E. A., and TSAO, C. H., Introduction to the theoretical and experimental analysis of stress and strain, New York, McGraw-Hill Book Co., Inc., 1958, xxx + 498 pp. $12.50.

GOODIER, J. N., and HODGE, P. G., JR., Elasticity and plasticity: The mathematical theory of elasticity; Mathematical theory of plasticity, New York, John Wiley & Sons, Inc. (Surveys in Applied Mathematics, Vol. 1), 1958, ix + 152 pp. $6.25.

HOLLIS, E. P., Bibliography of engineering seismology, San Francisco, Earthquake Engineering Research Institute, 1958, xii + 144 pp. $4.50.

KANI, G., Analysis of multistory frames, New York, Frederick Ungar Publishing Co., 1957, 113 pp. $4.50.

KAPLANSKY, I., HALL, M., JR., HEWITT, E., and FORTET, R., Some aspects of analysis and probability: Functional analysis; A survey of combinatorial analysis; A survey of abstract harmonic

analysis; recent advances in probability theory, New York, John Wiley & Sons, Inc. (Surveys in Applied Mathematics, Vol. 4), 1958, xi + 243 pp. $9.00.

KAUFMANN, W., Technische Hydro- und Aeromechanik, Berlin, Springer-Verlag, 1958, viii + 386 pp. DM 37.50.

LEIMANIS, E., and MINORSKY, N., Dynamics and nonlinear mechanics: Some recent advances in the dynamics of rigid bodies and celestial mechanics; The theory of oscillations, New York, John Wiley & Sons, Inc. (Surveys in Applied Mathematics, Vol. 2), 1958, xii + 206 pp. $7.75.

LUKASZEWICZ, J., and WARMUS, M., Metody Numeryczne i Graficzne, Warszawa, Panstwowe Wydawnictwo Naukowe, 1956, 429 pp. Cena 29.20.

SEMENOV, N. N., Some problems in chemical kinetics and reactivity, Vol I (translated from the Russian by M. Boudart), Princeton, N. J., Princeton University Press, 1958, xii + 239 pp. $4.50.

STANISLAW, G., Rachunek Tensorowy, Warszawa, Panstwowe Wydawnictwo Naukowe, 1956, 309 pp. Cena 30.70.

WERNITZ, W., Walz-Bohrreibung, Braunschweig, Friedr. Vieweg & Sohn, 1958, vi + 96 pp. DM 12.80.

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INDEX OF AUTHORS REFERRED TO IN THIS ISSUE

(NUMBERS USED ARE SERIAL NUMBERS OF REVIEWS)

Abbassov, A. A. 245
Abeles, P. W. 204
Abzug, M. J. 331
Achter, M. R. 144
Adams, W. M. 563
Adamskii, V. B. 366
Adkins, J. E. 47
Agostinelli, C. 475
Aksel'rod, Z. M. 226
Aleksapol'skii, D. Ya. 343
Alekseev, S. A. 85
Alexeev, L. P. 456, 371
Alexeyeva, R. N. 349
Allen, C. W. 221
Allen, H. J. 303
Allen, J. E. 493
Alperin, M. 494
Alpher, R. A. 509
Altschul, A. D. 260
Anderson, M. S. 97
Anevi, G. 181
Arkhangel'skii, V. A. 550
Armstrong, T. N. 232
Artsykov, A. P. 346
Asch, A. B. 589
Ashton, H. M. 373
Ashwood, P. F. 458
Au, T. 187
Averkiev, Yu. A. 136
Babaev, N. N. 581
Bader, M. 468
Badke, A. O. 121
Badzioch, S. 520
Baim, A. A. 88, 89
Bakanov, S. P. 524
Baker, R. M. L., Jr. 308
Barenblatt, G. I. 557
Barger, R. L. 355
Barnes, A. F. C. 238
Barrere, M. 421
Bartenev, G. M. 378
Bartz, D. R. 506
Batdorf, S. B. 208
Baumann, R. C. 502
Bazilevich, V. V. 516
Bayley, F. J. 305
Beane, B. J. 299
Bednarczyk, H. 505
Beeler, D. E. 359
Bell, J. F. W. 57
Belzer, J. 19
Benedikt, E. T. 503
Benjamin, R. J. 100
Bennett, W. E. 490
Benson, R. S. 452
Bernstein, I. B. 471
Bers, L. 287
Bert, C. W. 216
Berz, R. 131
Bigelow, W. C. 179
Bindermann, W. 536
Birkhoff, G. 405
Bishop, R. E. D. 30
Blackburn, W. S. 43
Blackett, J. H. 520
Blackman, V. H. 304
Blau, H. H. Jr. 401
Bogusz, W. 104
Bollinger, L. E. 424
Borisov, Yu. P. 556
Borot, H. 99
Bose, A. G. 37
Brenden, B. B. 402
Bretschneider, C. L. 337
Brinkman, H. C. 381
Brobeck, W. M. 448
Brooks, G. W. 491
Brosskamp, K. H. 523
Brown, W. M. 34
Brunn, P. 522
Bukacek, R. F. 272
Bullen, N. I. 333
Bulygin, I. P. 169
Burgess, D. S. 437
Burnett, H. C. 171
Bush, W. B. 467
Callahan, T. F. 75
Calvert, E. S. 489
Calvert, H. F. 485
Campbell, J. P. 356
Carafoli, E. 321
Carlson, W. C. A. 468
Carmel, M. M. 295
Carpenter, P. J. 348
Carrier, G. F. 567
Carriere, P. 300
Chaevskii, M. I. 112
Chafets, E. M. 20
Chang, Y. P. 403
Chao, B. T. 138, 139
Charlton, T. M. 211
Charwat, A. F. 308, 457
Chase, C. E. 515
Chastain, J. W. 409
Chawla, J. P. 478
Cheeseman, I. C. 490
Chen, K. K. 4
Chester, W. 472
Chinneck, A. 360
Chuang, F. 320
Chudinov, S. D. 583
Clark, J. W. 92
Claydon, D. G. W. 518
Clemensen, R. E. 448
Cobb, W. E. 540
Coleman, T. L. 334
Colwell, L. V. 137
Conway, H. G. 486
Courbon, J. 200
Coxon, M. 369
Cozzone, F. P. 23
Crausse, E. 474
Cresswell, D. J. 399
Csonka, P. 91
Culick, F. E. C. 312
Curle, N. 315
Czarnecki, K. R. 295
Dabora, E. K. 415
Dabrowski, R. 201
Dalmai, Gisele, ...422
Daskin, W. 504
Dat, R. 484
Davis, R. E. 463
Davydov, B. I. 383
Decker, R. F. 179
Degarmo, E. P. 233
Demin, A. I. 77
Denisenko, P. S. 347
Deriagin, B. V. 524
Devimeux, C. W. 338
Didkovskii, M. M. 259
DiMaggio, F. L. 115
Dingee, D. A. 409
Dokolov, E. Ya. 270
Donaldson, W. F. 437
Donegan, J. J. 477
Donnelly, R. J. 316
Dorn, J. E. 61
Doyle, T. C. 44
Drake, H. M. 363
Drakhlin, E. Kh. 398
Dub, O. 250
Dumortier, J. 431
Duncan, W. J. 36
Dutkiewicz, R. K. 407
Dyban, E. P. 281
Dzhimsheleishvili, G. A. ...258
Dzhimsheli, G. A. 257
Efleev, A. P. 555
Egen, R. A. 409
Eggers, A. J. Jr. 492
Eimer, C. 58
Ellington, J. P. 64
Ellis, J. S. 63
Emmons, H. W. 419
Engel, E. 71
Eskinazi, S. 469
Evans, Marjorie, W. 423
Evans, Martha W. 297
Eveson, G. F. 350
Evgrafov, M. A. 5
Ewing, W. M. 562
Fanelli, E. 193
Faneuff, C. E. 416
Fedorov, R. M. 456
Fedorov, V. N. 436
Feldman, L. 504
Felgar, R. P. 150
Ferguson, R. E. 433
Ferri, A. 504
Filipov, A. P. 103
Filler, F. M. 298
Firth, D. 586
Fischel, J. 363
Fischer, K. 126
Fisher, W. A. P. 175
Flugge, S. (edited by) ... 8
Forray, M. 79
Fortet, R. 6
Francis, J. R. D. 325
Frank, I. 386
Frankel, S. P. 14
Frankovic, A. 255
Freeman, J. W. 179
Frieman, E. A. 471
Frost, N. E. 149
Fuhs, A. E. 435
Galaktionov, V. A. 298
Galickii, V. M. 380
Gamski, K. 239
Garf, M. E. 173
Geckler, R. D. 463
Gelin, P. 392
Geminard, L. 188
Gerard, G. 182
Gerritsen, F. 552
Gerritsma, J. 582
Gevorkin, R. G. 370
Giangreco, E. 29, 93
Gilbert, M. 427, 428
Ginsburg, Ya. S. 229
Given, F. I. 423
Gladkov, A. V. 517
Glaser, H. 414
Glaser, P. E. 401
Glikman, V. F. 385
Gnedenko, B. V. 7
Gobza, R. N. 418
Godfrey, D. E. R. 48
Godnev, I. N. 379
Goldberg, J. E. 186
Golovin, G. Ya. 106
Golubovic, G. 205
Good, I. J. 10
Goodman, T. P. 212
Gordobey, A. T. 169
Govorov, A. N. 456
Gracey, W. 358
Greenspan, H. P. 567
Greyber, H. D. 509
Grigoljuk, E. I. 96
Grishkova, N. P. 159
Gross, E. P. 307
Grumer, J. 437
Gurevich, Ya. B. 168
Guseinov, N. M. 224
Gustafson, W. A. 284
Gutierrez, J. N. 192
Haberzak, A. 127
Hain, K. 220
Halberstadt, E. S. 373
Hall, H. 483
Hall, M. Jr. 6
Hallett, A. C. H. 316
Halverstadt, R. D. 142
Hansen, C. F. 372, 573
Harlow, F. H. 297
Harms, F. 131
Harris, D. L. 397
Harris, L. A. 100
Hartbower, C. E. 145
Hashimoto, H. 263
Haskind, M. D. 274
Hawksley, P. G. W. 520
Head, M. R. 369
Hebrant, F. 228
Heims, S. P. 372
Hendrickson, R. L. 455
Henzel, J. G. 387
Hertzberg, A. 367
Hewitt, E. 6
Hiba, Z. 198
Higgins, D. G. 458
Hill, J. A. F. 312
Hill, R. 246
Hilly, Y. 203
Hinkle, R. T. 215
Hirschhorn, J. 110
Hochberg, M. M. 153
Hoffman, G. A. 499
Holister, G. S. 156
Hollingsworth, B. J. 545
Horning, W. A. 405
Horlock, J. H. 283, 345
Horovitz, Beatrice, ...321
Horvay, G. 387

INDEX OF AUTHORS REFERRED TO IN THIS ISSUE *(Continued)*

(NUMBERS USED ARE SERIAL NUMBERS OF REVIEWS)

Houbolt, J. C. 491
Housner, G. W. 116, 565
Howard, C., Jr. 455
Howell, J. D. 214
Hrubecky, H. F. 526
Hsu, C. C. 479
Hu, L. W. 67
Huber, P. W. 365
Hunt, J. B. 143
Huntington, W. C. 132
Hunton, L. W. 288
Hus, C. R. 477
Hussmann, A. W. 450
Hutchings, J. W. 577
Irmay, S. 546
Ishiguro, S. 568
Ishikawa, T. 376
Iskritsky, D. E. 194
Ito, H. 269
Ivanilov, Yu. P. 123
Ivanov, A. I. 170
Jack, J. R. 313
Jaeger, L. G. 254
Jardetzky, W. S. 562
Jasper, N. H. 569
Jefferson, J. L. 344
Jenkins, L. R. 210
Jessop, H. T. 156
Johnson, D. 369
Johnson, D. C. 30
Johnson, W. 70
Johnston, K. 110
Jones, A. B. 590
Jones, J. B. 237
Jung, H. 389
Kabulov, V. K. 102, 195
Kacner, A. 81
Kammer, E. W. 162
Kantham, C. L. 113
Kao, S. K. 572
Kaplansky, I. 6
Kato, H. 574
Kato, T. 240
Katzoff, S. 355
Kaufman, A. N. 466
Kawata, K. 158
Kazandjan, P. K. 456
Kazantsev, E. I. 278
Kazimirovskaya, E. L. 151
Keller, S. Yu. 353
Keune, F. 326
Khessin, G. L. 155
Khinchin, A. Ya. 7
Khovakh, M. S. 444
Khovanskii, A. N. 3
Khovansky, G. S. 273
Khvingiya, M. V. 217
Kimura, S. 574
Kinzer G. D. 540
Klameth, E. 261
Klemperer, W. B. 503
Klumb, H. 521
Knoll, A. H. 92
Kobayasi, K. ..410, 442, 531
Kodochigov, P. N. 129
Kogan, S. Ya. 46
Kogan, V. I. 380
Kondak, M. A. 441
Kononeko, V. G. 135
Konokotin, V. V. 275
Kononov, Yu. I. 152
Konovalov, N. E. 456
Korobeynikov, V. P. 311
Korotkin, Ya. I. 94
Korsakevich, N. I. 164
Kovalev, N. N. 341
Kovtun, D. G. 25
Kraichnan, R. H. 382
Krasil'nikov, Yu. I. 247
Krasovskii, N. N. 31
Krause, N. A. 161
Kreith, F. 391
Kruglov, M. G. 453
Kruskal, M. D. 471
Kryuchin, A. F. 293
Krzywoblocki, M. Z. v. ..284
Kuehnel, H. A. 368
Kuethe, A. M. 314, 438
Kulsrud, R. M. 471
Kuperman, V. L. 251
Kusukawa, K. 292
Kuwabara, S. 267
Kuzmak, J. M. 544
Kviatkovskiĭ, V. S. 341
Laitone, E. V. 310
Landshoff, R. K. 464
Lapsley, J. T. 176
La Tegola, A. 29
Lazaryan, V. A. 107
Leck, J. H. 351
Lecomte, P. 488
Lees, L. 302
Legendre, R. 1, 282
Legostev, N. I. 330
Leimanis, E. 28
Leonard, E. V. 219
Leonkov, A. M. 454
Leonov, M. Ya. 56
Letner, H. R. 141
Leve, H. L. 186
Levin, A. M. 439
Lewandowski, A. 120
Libby, P. A. 390
Lidov, M. L. 285
Liebaut, M. A. 42
Likhovetsky, I. D. 349
Livshits, L. D. 65
Lobanov, T. Z. 128
Loshkin, A. Z. 94
Ludwig, G. 40
Lur'e, A. I. 45
McArdle J. G. 279
McBrearty, J. F. 487
McCarty, D. G. 560
McDevitt, J. B. 289
McFeron, D. E. 138
McGehee, J. R. 585
McIlroy, W. 470
MacKenzie, J. D. 264
McLean, E. A. 416
Maciocе, E. 459
Madejski, J. 69
Mandelker, J. 498
Mangler, K. W. 322
Mansell, C. J. 362
Margolis, D. 391
Margulies, R. S. 405
Marin, J. 66
Martin, B. W. 305, 399
Martinek, J. 114
Martynovsky, V. S. 371
Marx, G. 220
Matsuev, L. P. 252
Meadows, May T. 334
Medwadowski, S. J. 78
Medovar, B. I. 146
Megyeri, J. 73
Mellor, P. B. 70
Menkes, H. R. 438
Merchant, M. E. 140
Mertens, J. 429
Meyer, H. I. 545
Michael, D. H. 268
Miele, A. 500
Miesse, C. C. 525, 413
Mikhailiv, P. A. 174
Mikheyev, N. I. 169
Miles, J. W. 336
Miller, F. B. 570
Miller, F. M. 236
Miller, R. H. 451
Miller, R. W. 124
Mills, W. C. 230
Minassian, R. S. 55
Minkoff, G. J. 430
Minorsky, N. 28
Minton, P. 325
Mirajanzade, A. Kh. 245
Mironenko, V. T. 552
Mirsepassi, T. J. 384
Mirzoyan, A. A. 244
Miyagi, T. 265
Mkhitaryan, A. M. 553
Moore, F. K. 512
Morawetz, Cathleen S. 291
Morgan, W. B. 584
Morse, I. E., Jr. 215
Moss, G. F. 361
Mossakowska, Z. 54
Moutet, A. 421
Moutet, H. 421
Muller, G. M. 423
Munier-Jolain, J. P. 548
Mura, T. 50, 52
Murthy, K. N. 592
Murzewski, J. 84
Naboko, I. M. 527, 528
Nagai, N. 533, 535
Nanney, C. A. 416
Nan'niti, T. 575
Nechayev, V. D. 440
Nechayev, V. K. 108
Nechayev, Yu. N. 456
Nelson-Skornyakov, F. B. 554
Neuringer, J. L. 470
Newkirk, H. W. Jr. 402
Newman, A. D. 591
Newman, E. A. 17
Niblett, B. 304
Nicholson, L. F. 209
Nishikawa, K. 408
Nitsche, C. 218
Noritake, H. M. 157
Norris, C. B. 95
North, Mrs. N. A. 360
Nossov, S. S. 163
Noton, G. J. 41
Novikov, I. I. 377
Ogarkov, B. I. 60
Ohtake, T. 532, 538, 539
Olds, R. H. 501
Olsen, H. 513
Olszak, W. 84
Orlob, G. T. 543
Oshima, K. 510
Ostroumov, G. A. 473
Ostrovsky, G. M. 39
Outinen, H. 116
Page, R. H. 294
Page, W. A. 290
Palii, O. M. 235
Panarin, N. Ya. 51
Panteleev, S. I. 225
Parfitt, G. G. 242
Paria, G. 558
Paslay, P. R. 241
Patterson, G. N. 309
Pavlenko, V. F. 456
Pawlak, Z. 13
Pchelkin, Yu. M. 445
Peaceman, D. W. 560
Peixoto, J. P. 579
Penner, S. S. 420
Perkins, P. J. 335
Perron, O. 2
Peterson, D. F. 276
Peterson, J. B. 296
Phelps, E. H. 154
Phillips, W. H. 368
Picone, M. 11
Pines, B. Ia. 59
Pischanenko, V. V. 447
Pister, K. S. 78
Piszczek, K. 122
Plainevaux, J. E. 9
Plaxe, E. 20
Pogorelov, A. I. 109
Poirier, Y. 474
Poliakhov, N. N. 324
Popov, I. A. 165
Popova, T. A. 87
Postol'nik, Yu. S. 72
Potter, R. L. 429, 508
Potthoff, W. C. 237
Poulston, B. V. 443, 534
Powell, R. D., Jr. 348
Powley, H. S. 511
Powling, J. 434
Press, F. 562
Press, H. 334, 576
Prigorovsky, N. I. 155
Probert, R. P. 461
Prosnak, W. 332
Pullman, W. A. 450
Pustynnikov, V. G. 166
Rabinovich, D. I. 446
Rachinskii, B. N. 76
Radhakrishna, G. N. 543
Radoslawoff, T. 262
Rao, M. R. K. 592
Ratner, S. I. 172

(Continued on outside back cover)

INDEX OF AUTHORS REFERRED TO IN THIS ISSUE *(Continued)*

(NUMBERS USED ARE SERIAL NUMBERS OF REVIEWS)

Rebrov, L. 196
Redozubov, D. V. 388
Regel, V. R. 147
Reid, W. H. 397
Reman, G. H. 541
Riabinin, Iu. N. 65
Richardson, E. G. 514
Richmond, J. K. 437
Ridge, S. E. 18
Riftin, L. P. 227
Roberson, R. R. 496
Rockey, K. C. 101
Rodionov, B. L. 340
Rodionov, I. A. 259
Rollnik, H. 40
Romberg, W. 513
Rosenauer, N. 222
Rosner, D. E. 301
Rotem, Z. 400
Rowe, J. P. 179
Rowland, E. N. 497
Roy, M. 460
Rozental, A. I. 339
Rubatch, O. M. 86
Russo, A. 367
Ryabchenkov, A. V. 151
Rzheznikov, Yu. V. 349
Sabaneev, A. A. 342
Saffman, P. G. 547
Saito, H. 184
Saito, N. 240
Salamandra, G. D. ..527, 528
Sanuki, M. 574
Sasaki, S. 533, 535
Sato, Y. 564
Savic, P. 406
Sawczuk, A. 83
Scherrer, V. E. 416
Schuetz, A. 521
Schumann, W. 80
Seifferlein, Th. 425
Selberg, A. 199
Semanov, N. A. 253
Semeka, V. A. 449
Semenovker, I. E. 411
Semerchan, A. A. 298
Setty, S. K. 176
Sevier, J. R., Jr. 295
Shahinian, P. 144
Shakhramanov, G. S. 90
Sharma, M. G. 66
Shashin, Ya. 152
Shea, P. H. 542
Shein, V. B. 412
Shen, S. F. 479
Shepheard, E. R. 443
Sheppard, L. M. 323
Sherby, O. D. 61
Shercliff, J. A. 476
Shestakov, A. V. 202
Shimansky, Yu. A. 207
Shipley, E. E. 213
Shul'gin, D. F. 280
Shvartsman, G. A. 32
Shvetz, I. T. 281
Sidorov, E. A. 529
Sigal, I. Ya. 441
Sigalla, A. 318
Sih, N. S. 197
Simon, J. C. 338
Sivers, N. L. 94
Sizof, M. B. 26
Skachkoff, B. N. 38
Skene, W. T. 100
Skowronski, J. 119
Slibar, A. 241
Smetana, J. 248, 249
Smith, A. G. 357, 493
Smith, E. T. B. 462
Smith, G. T. 485
Smith, J. H. B. 322
Smith, W. A. W. 434
Snell, C. 156
Solyanik-Krassa, K. V. 74
Sparenberg, J. A. 53
Sparke, J. W. 489
Sparrow, E. M. 394
Spraragen, W. 231
Sreekantath, G. M. 354
Stalder, J. R. 393
Stanbrook, A. 364
Stansbury, J. G. 183
Stantsov, B. T. 77
Starr, V. P. 579
Stassi D'Alla, F. 566
Steffensen, J. F. 27
Stein, A. H. 35
Stein, B. A. 178
Stepanov, A. V. 148
Stern, M. 494
Storchi, E. 68
Stout, J. E. 310
Strauss, R. 238
Stringer, J. D. 134
Subbotin, A. F. 24
Suer, H. S. 100
Sullivan, N. 328
Summerlin, F. A. 328
Sutcliffe, H. 33
Sutherby, P. F. 327
Sutherland, R. A. 234
Takaisi, Y. 266
Tainov, A. I. 223
Tamate, O. 82
Tanaka, K. 184
Tanasawa, Y. 530, 531
533, 535, 537
Taylor, G. 547
Taylor, J. 493
Taylor, R. A. 289
Tchayevsky, M. I. 111
Tchucklin, S. G. 417
Temkin, A. G. 436
Terry, N. B. 62
Teverovskii, B. M. 396
Thompson, W. E. 133
Thomsen, E. G. 176
Timonov, V. V. 571
Timoshenko, V. V. 117
Ting, L. 98
Todorow, M. 191
Tomlinson, A. 134
Toyoda, S. 530, 537
Trigger, K. J. 139
Trubert, M. 484
Tsarenko, N. V. 395
Turiev, K. V. 129, 559
Turnbull, D. E. 41
Turner, R. C. 344
Tverskoi, N. P. 516
Tyabin, N. V. 243
Uberoi, M. S. 438
Uchastkin, P. V. 578
Umanskii, A. A. 190
Ungar, J. 125
Ushakov, V. N. 352
Van Zee, A. F. 157
Veletsos, A. S. 22
Velikanov, M. A. 256
Vereschchagin, L. F. 65, 298
Verghese, C. A. 354
Verigin, N. N. 561
Vertregt, M. 495
Vigness, I. 162
Voce, E. 180
Voreck, W. E. 448
Vossers, G. 580
Vosteen, L. F. 177
Waelbroeck, F. G. ..374, 375
Wagner, H. M. 15
Wakulicz, A. 13
Wallick, G. C. 277
Wang, C. J. 296
Warner, W. L. 232
Watson, J. 480, 481
Wayman, D. H. 508
Wells, R. A. 426
Wentzel, D. G. 319
Wergeland, H. 513
Whitsett, H. E. 542
Whitten, J. B. 368
Widdowson, A. E. 167
Wigglesworth, L. A. 49
Wilde, K. A. 432
Williams, D. E. 482
Williams, F. 435
Williams, F. A. 317
Williams, J. L. 350
Williams, M. L. 507
Williams, W. C. 363
Winter, E. F. 534
Wittmeyer, H. 105
Wituszynski, K. 206
Wolkovitch, J. 329
Woo, D. M. 70
Wood, L. A. 185
Woodcock, S. H. 402
Woodside, W. 544
Woolett, E. R. 12
Wooster, H. 494
Wolfe, M. O. W. 519
Worthy, W. D. 16
Wright, M. A. 17
Yablonskii, V. S. 271
Yamamoto, G. 532, 538
Yeates, J. E. Jr. 491
Yeh, G. C. K. 114
Yokley, C. R. 433
Yuan, S. W. 98, 549
Zahler, C. W. 21
Zaid, M. 79, 189
Zhitnikov, R. A. 148
Zhukovsky, M. I. 286
Zielenski, E. 404
Ziemba, S. 118
Ziemer, R. W. 467
Ziering, S. 307
Zinovieva, L. A. 551
Zuckerbrodt, P. 374, 375